THE

ASTRONOMICAL JOURNAL.

EDITED BY

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VOLUME I.

NOVEMBER, 1849, TO APRIL, 1851.

CAMBRIDGE:

JAMES MUNROE & CO.

1851.

JOHNSON REPRINT CORPORATION
111 Fifth Avenue, New York, N.Y. 10003

JOHNSON REPRINT COMPANY LIMITED
Berkeley Square House, London, W.1

First reprinting, 1964, Johnson Reprint Corporation

Printed in the U.S.A.

CAMBRIDGE:

METCALF AND COMPANY,

PRINTERS TO THE UNIVERSITY.

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VOL. I. CAMBRIDGE, NOVEMBER 2, 1849. NO. 1.

PREAMBLE.

The enthusiasm of astronomers and the liberality of friends of science in America have enabled me to commence the Astronomical Journal, with the full conviction that it will be permanently supported. Of its importance, — its necessity, indeed, — for the proper development of astronomy in our country, there can be but one opinion. Astronomy has already reached a stage of development in America, which entitles it to claim a higher position than has yet been accorded it, and which requires a larger scope for its future growth. The influence which a purely scientific journal, devoted exclusively to astronomy and its kindred departments of inquiry, may exert upon the future progress of the science is very great; and it is, therefore, with diffidence, but without hesitation, that I begin the work.

Such a work ought to support the dignity of a pure science, striving for the extension of the realm of human intellect; it should furnish the means of publication and prompt dissemination of discoveries and researches; and should promote harmony among astronomers, laboring for a common end, — while it furnishes an opportunity for the manly expression of differences of opinion.

It will be distinctly understood that the publication of statements or opinions implies no indorsement of them by the Editor. No communication will be published without the name of the author; and I desire to be held answerable for the accuracy of such articles or researches only, as may be published with my name or initial.

In the earnest hope that the establishment of the Astronomical Journal may be hereafter referred to, as an era for astronomy in America, I commend it to the sympathy and coöperation of the lovers and votaries of science.

BENJ. APTHORP GOULD, Jr.

DEVELOPMENT OF THE PERTURBATIVE FUNCTION OF PLANETARY MOTION.*

By BENJAMIN PEIRCE, LL. D.,

PERKINS PROFESSOR OF ASTRONOMY AND MATHEMATICS IN HARVARD UNIVERSITY.

The following development of the perturbative function has been made with the greatest care, and has been subjected to such tests and checks as would seem to insure its perfect accuracy. All terms are given, without any omission, to the fifth powers of the elements. It will be observed that, in the higher powers, the development differs materially from others which have been published.

The following notation is adopted: —

* This important paper was communicated in June last to Lieutenant Charles Henry Davis, Superintendent of the *Nautical Almanac*, who had commenced the publication of it in an independent form, for the use of his office; but who has, at the request of the Editor, had the goodness to communicate it to him, as forming a fitting commencement for the Astronomical Journal. G.

$a =$ the semi-major axis of the inner planet.
$l =$ its mean longitude.
$e =$ its eccentricity.
$\varpi =$ the longitude of its perihelion.
a', l', e', ϖ', are the corresponding values for the outer planet.
$\varphi_0 =$ the mutual inclination of the orbits.
$\theta_0 =$ the longitude of the ascending node of the orbit of the outer planet upon the inner one.

$$l_0 = l - l'.$$

$$\alpha = \frac{a}{a'}.$$

$b_s^{(i)} =$ the coefficient of cos. $i\,l$ in the development of $(1 - 2\,\alpha \cos. l + \alpha^2)^{-s}$.

$$g_s^i = b_s^{(i-1)} + b_s^{(i+1)}.$$

$$h_s^i = 4\,b_s^{(i)} + b_s^{(i-2)} + b_s^{(i+2)}.$$

$$\lambda = \sin. \tfrac{1}{2}\,\varphi_0.$$

D_α denotes the differential coefficient relatively to α.

$$\Sigma^n. A = (1 + \Delta)^n. A.$$
$$= \left(1 + n\,\Delta + \frac{n\,(n-1)}{1\,.\,2}\,\Delta^2 + \text{\&c.}\right) A.$$
$$= A + n\,\Delta\,A + \frac{n\,(n-1)}{1\,.\,2}\,\Delta^2 A + \text{\&c.}$$

in which $\Delta\,A$, $\Delta^2\,A$, &c., must not be confounded with products, but must be regarded as successive differences. Accents may be applied to Σ and Δ in this formula.

$$K^{(i)} = -\,2\,i\,b_{\frac{1}{2}}^{(i)} + \alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta\,K^{(i)} = b_{\frac{1}{2}}^{(i)}.$$

$$K_2^{(i)} = (4\,i^2 + 5\,i)\,b_{\frac{1}{2}}^{(i)} - (4\,i + 2)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} + \alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta\,K_2^{(i)} = -\,7\,i\,b_{\frac{1}{2}}^{(i)} + 4\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} = 4\,K^{(i)} + i\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^2\,K_2^{(i)} = 4\,b_{\frac{1}{2}}^{(i)}.$$

$$L_2^{(i)} = -\,4\,i^2\,b_{\frac{1}{2}}^{(i)} + 2\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} + \alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta\,L_2^{(i)} = 2\,i\,b_{\frac{1}{2}}^{(i)}.$$

$$K_3^{(i)} = -\,(8\,i^3 + 30\,i^2 + 26\,i)\,b_{\frac{1}{2}}^{(i)} + (12\,i^2 + 27\,i + 9)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} - (6\,i + 6)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} + \alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta\,K_3^{(i)} = (24\,i^2 + 31\,i)\,b_{\frac{1}{2}}^{(i)} - (26\,i + 13)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} + 7\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} = 7\,K_2^{(i)} + (2\,i + 1)\,K^{(i)} - 2\,i\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^2\,K_3^{(i)} = -\,44\,i\,b_{\frac{1}{2}}^{(i)} + 27\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} = 9\,(\Delta\,K_2^{(i)} - K^{(i)}) + i\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^3\,K_3^{(i)} = 27\,b_{\frac{1}{2}}^{(i)}.$$

$$L_3^{(i)} = (8\,i^3 + 14\,i^2 + 5\,i)\,b_{\frac{1}{2}}^{(i)} - (4\,i^2 + 7\,i + 4)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} - (2\,i - 1)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} + \alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta\,L_3^{(i)} = -\,(14\,i^2 + 5\,i)\,b_{\frac{1}{2}}^{(i)} + (3\,i + 6)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} + 3\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} = 3\,L_2^{(i)} + 3\,i\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} - (2\,i^2 + 5\,i)\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^2\,L_3^{(i)} = (10\,i - 1)\,b_{\frac{1}{2}}^{(i)} - \alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} = -\,K^{(i)} + (8\,i - 1)\,b_{\frac{1}{2}}^{(i)}.$$

$$M_3^{(i)} = \Delta'\,L_3^{(i)} = -\,(4\,i^2 + 3\,i)\,b_{\frac{1}{2}}^{(i)} + \alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} + \alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} = L_2^{(i)} - K^{(i)} - 5\,i\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta\,M_3^{(i)} = 3\,i\,b_{\frac{1}{2}}^{(i)} + \alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} = K^{(i)} + 5\,i\,b_{\frac{1}{2}}^{(i)}. \qquad \Delta^2\,M_3^{(i)} = b_{\frac{1}{2}}^{(i)}.$$

$$N_3^{(i)} = -\,(2\,i + 1)\,\alpha\,b_{\frac{3}{2}}^{(i)} + \alpha^2\,D_\alpha\,b_{\frac{3}{2}}^{(i)}. \qquad \Delta\,N_3^{(i)} = 5\,\alpha\,b_{\frac{3}{2}}^{(i)}.$$

$$O_3^{(i)} = (2\,i + 3)\,\alpha\,b_{\frac{3}{2}}^{(i)} + \alpha^2\,D_\alpha\,b_{\frac{3}{2}}^{(i)} = N_3^{(-i)} + 4\,\alpha\,b_{\frac{3}{2}}^{(i)}. \qquad \Delta\,O_3^{(i)} = -\,3\,\alpha\,b_{\frac{3}{2}}^{(i)}.$$

$$P_3^{(i)} = -\,(2\,i - 1)\,\alpha\,g_{\frac{3}{2}}^{(i)} + \alpha^2\,D_\alpha\,g_{\frac{3}{2}}^{(i)}. \qquad \Delta\,P_3^{(i)} = \alpha\,g_{\frac{3}{2}}^{(i)}.$$

$$K_4^{(i)} = (16\,i^4 + 120\,i^3 + 283\,i^2 + 206\,i)\,b_{\frac{1}{2}}^{(i)} - (32\,i^3 + 168\,i^2 + 236\,i + 64)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} + (24\,i^2 + 78\,i + 48)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)}$$
$$-\,(8\,i + 12)\,\alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)} + \alpha^4\,D_\alpha^4\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta\,K_4^{(i)} = -\,(68\,i^3 + 261\,i^2 + 232\,i)\,b_{\frac{1}{2}}^{(i)} + (108\,i^2 + 246\,i + 82)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} - (57\,i + 57)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} + 10\,\alpha^3\,D^3\,b_{\frac{1}{2}}^{(i)}$$
$$= 10\,K_3^{(i)} + (3\,i + 3)\,K_2^{(i)} - (6\,i + 2)\,K^{(i)} + 9\,i\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^2\,K_4^{(i)} = (210\,i^2 + 278\,i)\,b_{\frac{1}{2}}^{(i)} - (240\,i + 120)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} + 68\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} = 68\,K_2^{(i)} + (32\,i + 16)\,K^{(i)} + (2\,i^2 - 30\,i)\,b_{\frac{1}{2}}^{(i)}.$$

$\Delta^3 K_4^{(i)} = -398\, i\, b_{\frac{1}{2}}^{(i)} + 256\, \alpha\, D_\alpha b_{\frac{1}{2}}^{(i)}.$

$\Delta^4 K_4^{(i)} = 256\, b_{\frac{1}{2}}^{(i)}.$

$L_4^{(i)} = -(16\, i^4 + 60\, i^3 + 64\, i^2 + 22\, i)\, b_{\frac{1}{2}}^{(i)} + (16\, i^3 + 48\, i^2 + 46\, i + 16)\, \alpha\, D_\alpha b_{\frac{1}{2}}^{(i)} - (9\, i + 12)\, \alpha^2 D_\alpha^2\, b_{\frac{1}{2}}^{(i)} - 4\, i\, \alpha^3 D_\alpha^3\, b_{\frac{1}{2}}^{(i)} + \alpha^4 D_\alpha^4\, b_{\frac{1}{2}}^{(i)}.$

$= K_4^{(i)} + (4\, i + 12)\, K_3^{(i)} + (9\, i + 12)\, K_2^{(i)} - (12\, i + 4)\, K^{(i)} + 16\, i\, b_{\frac{1}{2}}^{(i)}.$

$\Delta L_4^{(i)} = (48\, i^3 + 70\, i^2 + 24\, i)\, b_{\frac{1}{2}}^{(i)} - (32\, i^2 + 52\, i + 22)\, \alpha\, D_\alpha b_{\frac{1}{2}}^{(i)} - (8\, i - 15)\, \alpha^2 D_\alpha^2\, b_{\frac{1}{2}}^{(i)} + 6\, \alpha^3 D_\alpha^3\, b_{\frac{1}{2}}^{(i)}.$

$\Delta^2 L_4^{(i)} = -(92\, i^2 + 26\, i)\, b_{\frac{1}{2}}^{(i)} + (32\, i + 48)\, \alpha\, D_\alpha b_{\frac{1}{2}}^{(i)} + 16\, \alpha^2 D_\alpha^2\, b_{\frac{1}{2}}^{(i)}.$

$\Delta^3 L_4^{(i)} = 82\, i\, b_{\frac{1}{2}}^{(i)} - 16\, \alpha\, D_\alpha b_{\frac{1}{2}}^{(i)}.$

$M_4^{(i)} = \Delta^4 L_4^{(i)} = -(8\, i^3 + 18\, i^2 + 4\, i)\, b_{\frac{1}{2}}^{(i)} + 2\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} + (6\, i + 3)\, \alpha^2 D_\alpha^2\, b_{\frac{1}{2}}^{(i)} - 2\, \alpha^3 D_\alpha^3\, b_{\frac{1}{2}}^{(i)}.$

$\Delta M_4^{(i)} = (12\, i^2 + 2\, i)\, b_{\frac{1}{2}}^{(i)} + 8\, i\, \alpha\, D_\alpha b_{\frac{1}{2}}^{(i)} - 8\, \alpha^2 D_\alpha^2\, b_{\frac{1}{2}}^{(i)}.$

$\Delta^2 M_4^{(i)} = 2\, i\, b_{\frac{1}{2}}^{(i)} - 16\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)}.$

$\Delta^3 M_4^{(i)} = -16\, b_{\frac{1}{2}}^{(i)}.$

$N_4^{(i)} = (16\, i^4 - 9\, i^2)\, b_{\frac{1}{2}}^{(i)} - 8\, i^2\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} - 8\, i^2\, \alpha^2 D_\alpha^2\, b_{\frac{1}{2}}^{(i)} + 4\, \alpha^3 D_\alpha^3\, b_{\frac{1}{2}}^{(i)} + \alpha^4 D_\alpha^4\, b_{\frac{1}{2}}^{(i)}.$

$\Delta N_4^{(i)} = (-28\, i^3 + 23\, i^2 - 2\, i)\, b_{\frac{1}{2}}^{(i)} + (-4\, i^2 + 18\, i - 6)\, \alpha\, D_\alpha b_{\frac{1}{2}}^{(i)} + (9\, i + 3)\, \alpha^2 D_\alpha^2\, b_{\frac{1}{2}}^{(i)} + 2\, \alpha^3 D_\alpha^3\, b_{\frac{1}{2}}^{(i)}.$

$^2 N_4^{(i)} = (22\, i^2 - 16\, i)\, b_{\frac{1}{2}}^{(i)} - 8\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} - 4\, \alpha^2 D_\alpha^2\, b_{\frac{1}{2}}^{(i)}.$

$O_4^{(i)} = -4\, i^2\, b_{\frac{1}{2}}^{(i)} + (-8\, i^2 + 12)\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} + 18\, \alpha^2 D_\alpha^2\, b_{\frac{1}{2}}^{(i)} + 4\, \alpha^3 D_\alpha^3\, b_{\frac{1}{2}}^{(i)}.$

$\Delta O_4^{(i)} = 13\, i^2\, b_{\frac{1}{2}}^{(i)} - 8\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} - 4\, \alpha^2 D_\alpha^2\, b_{\frac{1}{2}}^{(i)}.$

$P_4^{(i)} = (4\, i^2 + 9\, i + 3)\, \alpha\, b_{\frac{3}{2}}^{(i)} - (4\, i + 4)\, \alpha^2 D_\alpha b_{\frac{3}{2}}^{(i)} + \alpha^3 D_\alpha^2\, b_{\frac{3}{2}}^{(i)}.$

$\Delta P_4^{(i)} = -(15\, i + 7)\, \alpha\, b_{\frac{3}{2}}^{(i)} + 8\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)}.$

$\Delta^2 P_4^{(i)} = 38\, \alpha\, b_{\frac{3}{2}}^{(i)}.$

$Q_4^{(i)} = (4\, i^2 + 7\, i + 1)\, \alpha\, b_{\frac{3}{2}}^{(i)} + (4\, i + 4)\, \alpha^2 D_\alpha\, b_{\frac{3}{2}}^{(i)} + \alpha^3 D_\alpha^2\, b_{\frac{3}{2}}^{(i)} = P_4^{(-i)} + (16\, i - 2)\, \alpha\, b_{\frac{3}{2}}^{(i)} + 8\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)}.$

$\Delta Q_4^{(i)} = -(i + 1)\, b_{\frac{3}{2}}^{(i)}.$

$\Delta^2 Q_4^{(i)} = 2\, b_{\frac{3}{2}}^{(i)}.$

$R_4^{(i)} = -(4\, i^2 + 8\, i + 2)\, \alpha\, b_{\frac{3}{2}}^{(i)} + 4\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)} + \alpha^3\, D_\alpha^2\, b_{\frac{3}{2}}^{(i)}.$

$S_4^{(i)} = (6\, i + 2)\, \alpha\, b_{\frac{3}{2}}^{(i)} - 4\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)}.$

$T_4^{(i)} = (4\, i^2 + i - 2)\, \alpha\, g_{\frac{3}{2}}^{(i)} - 4\, i\, \alpha^2 D_\alpha g_{\frac{3}{2}}^{(i)} + \alpha^3\, D_\alpha^2\, g_{\frac{3}{2}}^{(i)}.$

$\Delta T_4^{(i)} = -(7\, i - 4)\, \alpha\, g_{\frac{3}{2}}^{(i)} + 4\, \alpha^2\, D_\alpha\, g_{\frac{3}{2}}^{(i)}.$ $\qquad \Delta^2 T_4^{(i)} = 4\, \alpha\, g_{\frac{3}{2}}^{(i)}.$

$U_4^{(i)} = -(4\, i^2 - 2)\, \alpha\, g_{\frac{3}{2}}^{(i)} + 4\, \alpha^2\, D_\alpha\, g_{\frac{3}{2}}^{(i)} + \alpha^3\, D_\alpha^2\, g_{\frac{3}{2}}^{(i)}.$ $\qquad \Delta U_4^{(i)} = 2\, i\, \alpha\, g_{\frac{3}{2}}^{(i)}.$

$$K_5^{(i)} = -(32\,i^5 + 400\,i^4 + 1790\,i^3 + 3360\,i^2 + 2194\,i)\,b_{\frac{1}{2}}^{(i)} + (80\,i^4 + 760\,i^3 + 2375\,i^2 + 2610\,i + 625)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)}$$
$$-(80\,i^3 + 540\,i^2 + 1040\,i + 500)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} + (40\,i^2 + 170\,i + 150)\,\alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)} - (10\,i + 20)\,\alpha^4\,D_\alpha^4\,b_{\frac{1}{2}}^{(i)} + \alpha^5\,D_\alpha^5\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta K_5^{(i)} = (176\,i^4 + 1341\,i^3 + 3231\,i^2 + 2400\,i)\,b_{\frac{1}{2}}^{(i)} - (368\,i^3 + 1956\,i^2 + 2778\,i + 753)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)}$$
$$+ (288\,i^2 + 942\,i + 580)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} - (100\,i + 150)\,\alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)} + 13\,\alpha^4\,D_\alpha^4\,b_{\frac{1}{2}}^{(i)}$$
$$= 13\,K_4^{(i)} + (4\,i + 6)\,K_3^{(i)} - (12\,i + 8)\,K_2^{(i)} + (36\,i + 9)\,K^{(i)} - 64\,i\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^2 K_5^{(i)} = -(764\,i^3 + 2988\,i^2 + 2710\,i)\,b_{\frac{1}{2}}^{(i)} + (1266\,i^2 + 2913\,i + 971)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} - (696\,i + 696)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} + 127\,\alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)}$$
$$= 127\,K_3^{(i)} + (66\,i + 66)\,K_2^{(i)} + (6\,i^2 - 120\,i - 40)\,K^{(i)} - (12\,i^2 - 182\,i)\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^3 K_5^{(i)} = (2414\,i^2 + 3259\,i)\,b_{\frac{1}{2}}^{(i)} - (2870\,i + 1135)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} + 815\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)}$$
$$= 815\,K_2^{(i)} + (510\,i + 255)\,K^{(i)} + (51\,i^2 - 456\,i)\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^4 K_5^{(i)} = -4694\,i\,b_{\frac{1}{2}}^{(i)} + 3125\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^5 K_5^{(i)} = 3125\,b_{\frac{1}{2}}^{(i)}.$$

$$L_5^{(i)} = (32\,i^5 + 240\,i^4 + 614\,i^3 + 648\,i^2 + 258\,i)\,b_{\frac{1}{2}}^{(i)} - (48\,i^4 + 280\,i^3 + 549\,i^2 + 460\,i + 135)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)}$$
$$+ (16\,i^3 + 84\,i^2 + 160\,i + 108)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} + (8\,i^2 + 6\,i - 18)\,\alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)} - (6\,i + 4)\,\alpha^4\,D_\alpha^4\,b_{\frac{1}{2}}^{(i)} + \alpha^5\,D_\alpha^5\,b_{\frac{1}{2}}^{(i)}$$
$$= K_5^{(i)} + (4\,i + 16)\,K_4^{(i)} + (12\,i + 24)\,K_3^{(i)} - (24\,i + 16)\,K_2^{(i)} + (64\,i + 16)\,K^{(i)} - 108\,i\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta L_5^{(i)} = -(136\,i^4 + 546\,i^3 + 668\,i^2 + 280\,i)\,b_{\frac{1}{2}}^{(i)} + (156\,i^3 + 489\,i^2 + 498\,i + 167)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)}$$
$$-(18\,i^2 + 117\,i + 128)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} - (31\,i - 6)\,\alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)} + 9\,\alpha^4\,D_\alpha^4\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^2 L_5^{(i)} = (428\,i^3 + 710\,i^2 + 310\,i)\,b_{\frac{1}{2}}^{(i)} - (338\,i^2 + 555\,i + 229)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} - (38\,i - 160)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} + 51\,\alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^3 L_5^{(i)} = -(882\,i^2 + 348\,i)\,b_{\frac{1}{2}}^{(i)} + (399\,i + 477)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} + 117\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^4 L_5^{(i)} = 906\,i\,b_{\frac{1}{2}}^{(i)} - 243\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)}.$$

$$M_5^{(i)} = \Delta' L_5^{(i)} = (16\,i^4 + 72\,i^3 + 47\,i^2 - 52\,i)\,b_{\frac{1}{2}}^{(i)} + (24\,i^2 + 66\,i + 7)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} - (24\,i^2 + 66\,i + 28)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)}$$
$$+ (16\,i + 18)\,\alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)} - 3\,\alpha^4\,D_\alpha^4\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta M_5^{(i)} = -(36\,i^3 + 27\,i^2 - 74\,i)\,b_{\frac{1}{2}}^{(i)} - (36\,i^2 + 102\,i + 21)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} + (69\,i + 48)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} - 21\,\alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^2 M_5^{(i)} = (6\,i^2 - 109\,i)\,b_{\frac{1}{2}}^{(i)} + (160\,i + 53)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)} - 95\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^3 M_5^{(i)} = 189\,i\,b_{\frac{1}{2}}^{(i)} - 243\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^4 M_5^{(i)} = -243\,b_{\frac{1}{2}}^{(i)}.$$

$$N_5^{(i)} = -(32\,i^5 + 80\,i^4 + 26\,i^3 - 12\,i^2 + 10\,i)\,b_{\frac{1}{2}}^{(i)} + (16\,i^4 + 40\,i^3 + 37\,i^2 + 18\,i + 5)\,\alpha\,D_\alpha\,b_{\frac{1}{2}}^{(i)}$$
$$+ (16\,i^3 + 12\,i^2 - 8\,i - 4)\,\alpha^2\,D_\alpha^2\,b_{\frac{1}{2}}^{(i)} - (8\,i^2 + 14\,i + 6)\,\alpha^3\,D_\alpha^3\,b_{\frac{1}{2}}^{(i)} - (2\,i - 4)\,\alpha^4\,D_\alpha^4\,b_{\frac{1}{2}}^{(i)} + \alpha^5\,D_\alpha^5\,b_{\frac{1}{2}}^{(i)}.$$

$$\Delta N_5^{(i)} = (96\, i^4 + 44\, i^3 - 21\, i^2 + 10\, i)\, b_{\frac{1}{2}}^{(i)} - (24\, i^3 + 62\, i^2 + 18\, i + 5)\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} - (44\, i^2 - 8\, i - 4)\, \alpha^2\, D_\alpha^2\, b_{\frac{1}{2}}^{(i)}.$$

$$+ (6\, i + 22)\, \alpha^3\, D_\alpha^3\, b_{\frac{1}{2}}^{(i)} + 5\, \alpha^4\, D_\alpha^4\, b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^2 N_5^{(i)} = -(192\, i^3 - 88\, i^2 + 18\, i)\, b_{\frac{1}{2}}^{(i)} + (12\, i^2 + 115\, i - 25)\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} + (60\, i + 8)\, \alpha^2\, D_\alpha^2\, b_{\frac{1}{2}}^{(i)} + 7\, \alpha^3\, D_\alpha^3\, b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^3 N_5^{(i)} = (220\, i^2 - 101\, i)\, b_{\frac{1}{2}}^{(i)} - (20\, i + 7\, i)\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} - 35\, \alpha^2\, D_\alpha^2\, b_{\frac{1}{2}}^{(i)}.$$

$$O_5^{(i)} = \Delta'\, N_5^{(i)} = -(56\, i^4 + 162\, i^3 + 130\, i^2 + 12\, i)\, b_{\frac{1}{2}}^{(i)} + (28\, i^3 + 87\, i^2 + 84\, i + 27)\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)}$$

$$+ (18\, i^2 + 3\, i - 16)\, \alpha^2\, D_\alpha^2\, b_{\frac{1}{2}}^{(i)} - (11\, i + 6)\, \alpha^3\, D_\alpha^3\, b_{\frac{1}{2}}^{(i)} + \alpha^4\, D_\alpha^4\, b_{\frac{1}{2}}^{(i)}.$$

$$\Delta O_5^{(i)} = (136\, i^3 + 129\, i^2 + 12\, i)\, b_{\frac{1}{2}}^{(i)} - (38\, i^2 + 94\, i + 33)\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} - (11\, i - 16)\, \alpha^2\, D_\alpha^2\, b_{\frac{1}{2}}^{(i)} + 11\, \alpha^3\, D_\alpha^3\, b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^2 O_5^{(i)} = -(192\, i^2 + 4\, i)\, b_{\frac{1}{2}}^{(i)} + (15\, i + 81)\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} + 4\, i\, \alpha^2\, D_\alpha^2\, b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^3 O_5^{(i)} = 91\, i\, b_{\frac{1}{2}}^{(i)} + \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)}.$$

$$P_5^{(i)} = \Delta'^2\, N_5^{(i)} = -(56\, i^3 + 126\, i^2 + 70\, i)\, b_{\frac{1}{2}}^{(i)} + (12\, i^2 + 45\, i + 31)\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} + 18\, i\, \alpha^2\, D_\alpha^2\, b_{\frac{1}{2}}^{(i)} - 5\, \alpha^3\, D_\alpha^3\, b_{\frac{1}{2}}^{(i)}.$$

$$\Delta P_5^{(i)} = (88\, i^2 + 65\, i)\, b_{\frac{1}{2}}^{(i)} - (6\, i + 31)\, \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)} - 15\, \alpha^2\, D_\alpha^2\, b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^2 P_5^{(i)} = -68\, i\, b_{\frac{1}{2}}^{(i)} + \alpha\, D_\alpha\, b_{\frac{1}{2}}^{(i)}.$$

$$\Delta^3 P_5^{(i)} = b_{\frac{1}{2}}^{(i)}.$$

$$Q_5^{(i)} = -(8\, i^3 + 42\, i^2 + 59\, i + 16)\, \alpha\, b_{\frac{3}{2}}^{(i)} + (12\, i^2 + 39\, i + 24)\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)} - (6\, i + 9)\, \alpha^3\, D_\alpha^2\, b_{\frac{3}{2}}^{(i)} + \alpha^4\, D_\alpha^3\, b_{\frac{3}{2}}^{(i)}.$$

$$\Delta Q_5^{(i)} = (40\, i^2 + 89\, i + 28)\, \alpha\, b_{\frac{3}{2}}^{(i)} - (42\, i + 41)\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)} + 11\, \alpha^3\, D_\alpha^2\, b_{\frac{3}{2}}^{(i)}.$$

$$\Delta^2 Q_5^{(i)} = -(152\, i + 67)\, \alpha\, b_{\frac{3}{2}}^{(i)} + 85\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)}.$$

$$\Delta^3 Q_5^{(i)} = 389\, \alpha\, b_{\frac{3}{2}}^{(i)}.$$

$$R_5^{(i)} = (8\, i^3 + 6\, i^2 - 13\, i - 2)\, \alpha\, b_{\frac{3}{2}}^{(i)} + (12\, i^2 + 9\, i - 6)\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)} - (6\, i + 3)\, \alpha^3\, D_\alpha^2\, b_{\frac{3}{2}}^{(i)} + \alpha^4\, D_\alpha^3\, b_{\frac{3}{2}}^{(i)}.$$

$$\Delta R_5^{(i)} = (8\, i^2 + 15\, i + 2)\, \alpha\, b_{\frac{3}{2}}^{(i)} + (10\, i + 11)\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)} + 3\, \alpha^3\, D_\alpha^2\, b_{\frac{3}{2}}^{(i)}.$$

$$\Delta^2 R_5^{(i)} = \alpha\, b_{\frac{3}{2}}^{(i)} + \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)}.$$

$$\Delta^3 R_5^{(i)} = \alpha\, b_{\frac{3}{2}}^{(i)}.$$

$$S_5^{(i)} = (8\, i^3 + 18\, i^2 + 6\, i)\, \alpha\, b_{\frac{3}{2}}^{(i)} - (4\, i^2 + 3\, i + 1)\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)} - (2\, i + 2)\, \alpha^2\, D_\alpha^2\, b_{\frac{3}{2}}^{(i)} + \alpha^4\, D_\alpha^3\, b_{\frac{3}{2}}^{(i)}.$$

$$\Delta S_5^{(i)} = -(30\, i^2 + 10\, i - 2)\, \alpha\, b_{\frac{3}{2}}^{(i)} + (3\, i - 1)\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)} + 7\, \alpha^3\, D_\alpha^2\, b_{\frac{3}{2}}^{(i)}.$$

$$\Delta^2 S_5^{(i)} = (78\, i - 28)\, \alpha\, b_{\frac{3}{2}}^{(i)} + 25\, \alpha^2\, D\, b_{\frac{3}{2}}^{(i)}.$$

$$T_5^{(i)} = \Delta'\, S_5^{(i)} = (12\, i^2 + 25\, i + 6)\, \alpha\, b_{\frac{3}{2}}^{(i)} - (16\, i + 13)\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)} + 5\, \alpha^3\, D_\alpha^2\, b_{\frac{3}{2}}^{(i)}.$$

$$\Delta T_5^{(i)} = -(49\, i + 16)\, \alpha\, b_{\frac{3}{2}}^{(i)} + 33\, \alpha^2\, D_\alpha\, b_{\frac{3}{2}}^{(i)}.$$

$$\Delta^2 T_5^{(i)} = 131\, \alpha\, b_{\frac{3}{2}}^{(i)}.$$

$$U_5^{(i)} = -(8\,i^3 - 6\,i^2 - 8\,i)\,\alpha\,b_{\frac{3}{2}}^{(i)} - (4i^2 - 13\,i - 12)\,\alpha^2 D_\alpha\,b_{\frac{3}{2}}^{(i)} + (2\,i + 8)\,\alpha^3 D_\alpha^2\,b_{\frac{3}{2}}^{(i)} + \alpha^4 D_\alpha^3 b_{\frac{3}{2}}^{(i)}.$$

$$\Delta\,U_5^{(i)} = -(2\,i^2 - 12\,i + 6)\,\alpha\,b_{\frac{3}{2}}^{(i)} + (3\,i + 2)\,\alpha^2 D_\alpha\,b_{\frac{3}{2}}^{(i)} + \alpha^3 D_\alpha^2 b_{\frac{3}{2}}^{(i)}.$$

$$\Delta^2\,U_5^{(i)} = -(6\,i - 16)\,\alpha\,b_{\frac{3}{2}}^{(i)} + 5\,\alpha^2 D_\alpha\,b_{\frac{3}{2}}^{(i)}.$$

$$V_5^{(i)} = \Delta'\,U_5^{(i)} = -(20\,i^2 + 15\,i + 1)\,\alpha\,b_{\frac{3}{2}}^{(i)} - (16\,i + 11)\,\alpha^2 D_\alpha\,b_{\frac{3}{2}}^{(i)} - 3\,\alpha^3\,D_\alpha^2\,b_{\frac{3}{2}}^{(i)}.$$

$$\Delta\,V_5^{(i)} = -(9\,i - 7)\,\alpha\,b_{\frac{3}{2}}^{(i)} - \alpha^2 D_\alpha\,b_{\frac{3}{2}}^{(i)}.$$

$$\Delta^2\,V_5^{(i)} = -17\,\alpha\,b_{\frac{3}{2}}^{(i)}.$$

$$W_5^{(i)} = -(8\,i^3 + 18\,i^2 - i - 9)\,\alpha\,g_{\frac{3}{2}}^{(i)} + (12\,i^2 + 15\,i - 3)\,\alpha^2 D_\alpha\,g_{\frac{3}{2}}^{(i)} - (6\,i + 3)\,\alpha^3 D_\alpha^2\,g_{\frac{3}{2}}^{(i)} + \alpha^4 D_\alpha^3\,g_{\frac{3}{2}}^{(i)}.$$

$$\Delta\,W_5^{(i)} = (24\,i^2 + 5\,i - 13)\,\alpha\,g_{\frac{3}{2}}^{(i)} - (26\,i - 1)\,\alpha^2 D_\alpha\,g_{\frac{3}{2}}^{(i)} + 7\,\alpha^3 D_\alpha^2\,g_{\frac{3}{2}}^{(i)}.$$

$$\Delta^2\,W_5^{(i)} = -(44\,i - 27)\,\alpha\,g_{\frac{3}{2}}^{(i)} + 27\,\alpha^2 D_\alpha\,g_{\frac{3}{2}}^{(i)}.$$

$$\Delta^3\,W_5^{(i)} = 27\,\alpha\,g_{\frac{3}{2}}^{(i)}.$$

$$X_5^{(i)} = (8\,i^3 + 6\,i^2 - 5\,i - 3)\,\alpha\,g_{\frac{3}{2}}^{(i)} - (4\,i^2 + 11\,i - 1)\,\alpha^2 D_\alpha\,g_{\frac{3}{2}}^{(i)} - (2\,i - 5)\,\alpha^3 D_\alpha^2\,g_{\frac{3}{2}}^{(i)} + \alpha^4 D_\alpha^3\,g_{\frac{3}{2}}^{(i)}.$$

$$\Delta\,X_5^{(i)} = -(14\,i^2 - i - 7)\,\alpha\,g_{\frac{3}{2}}^{(i)} + (3\,i + 13)\,\alpha^2 D_\alpha\,g_{\frac{3}{2}}^{(i)} + 3\,\alpha^3 D_\alpha^2\,g_{\frac{3}{2}}^{(i)}.$$

$$\Delta^2\,X_5^{(i)} = (10\,i - 1)\,\alpha\,g_{\frac{3}{2}}^{(i)} - \alpha^2\,D_\alpha\,g_{\frac{3}{2}}^{(i)}.$$

$$Y_5^{(i)} = \Delta'\,X_5^{(i)} = (4\,i^2 + 3\,i - 1)\,\alpha\,g_{\frac{3}{2}}^{(i)} - 3\,\alpha^2\,D_\alpha g_{\frac{3}{2}}^{(i)} - \alpha^3\,D_\alpha^2\,g_{\frac{3}{2}}^{(i)}.$$

$$\Delta\,Y_5^{(i)} = -(3\,i + 1)\,\alpha\,g_{\frac{3}{2}}^{(i)} - \alpha^2\,D_\alpha\,g_{\frac{3}{2}}^{(i)}.$$

$$\Delta^2\,Y_5^{(i)} = -\alpha\,g_{\frac{3}{2}}^{(i)}.$$

$$Z_5^{(i)} = -(2\,i + 2)\,\alpha^2\,b_{\frac{5}{2}}^{(i)} + \alpha^3\,D_\alpha\,b_{\frac{5}{2}}^{(i)}.$$

$$\Delta\,Z_5^{(i)} = 9\,\alpha^2\,b_{\frac{5}{2}}^{(i)}.$$

$$\mathbf{A}_5^{(i)} = \Delta'\,Z_5^{(i)} = (4\,i + 8)\,\alpha^2\,b_{\frac{5}{2}}^{(i)}.$$

$$\Delta\,\mathbf{A}_5^{(i)} = -16\,\alpha^2\,b_{\frac{5}{2}}^{(i)}.$$

$$\mathbf{B}_5^{(i)} = -2\,i\,\alpha^2\,g_{\frac{5}{2}}^{(i)} + \alpha^3\,D_\alpha\,g_{\frac{5}{2}}^{(i)}.$$

$$\Delta\,\mathbf{B}_5^{(i)} = 5\,\alpha^2\,g_{\frac{5}{2}}^{(i)}.$$

$$\mathbf{C}_5^{(i)} = \Delta'\,\mathbf{B}_5^{(i)} = (4\,i + 4)\,\alpha^2\,g_{\frac{5}{2}}^{(i)}.$$

$$\Delta\,\mathbf{C}_5^{(i)} = -8\,\alpha^2\,g_{\frac{5}{2}}^{(i)}.$$

$$\mathbf{D}_5^{(i)} = -(2\,i - 2)\,\alpha^2\,h_{\frac{5}{2}}^{(i)} + \alpha^3\,D_\alpha\,h_{\frac{5}{2}}^{(i)}.$$

$$\Delta\,\mathbf{D}_5^{(i)} = \alpha^2\,h_{\frac{5}{2}}^{(i)}.$$

If, then, $\Delta_i\,R$ denotes any term corresponding to i of the perturbative function, we have

$$\begin{aligned}
a'\,\Delta_i\,R = {} & \Big[\tfrac{1}{2}\,b_{\frac{1}{2}} + \tfrac{1}{8}\,(e^2 + e'^2)\,L_2 + \tfrac{1}{128}\,(e^4 + 4\,e^2 e'^2 + e'^4)\,N_4 + \tfrac{1}{64}\,e'^4\,O_4 + \tfrac{1}{32}\,e^2 e'^2\,\Sigma.O_4 - \tfrac{1}{4}\,\lambda^2\,\alpha\,g_{\frac{3}{2}} \\
& + \tfrac{1}{16}\,(e^2 + e'^2)\,\lambda^2\,U_4 + \tfrac{3}{16}\,\lambda^4\,\alpha^2\,h_{\frac{5}{2}}\Big]^{(i)} \cos.\,i\,l_0 \\
& - \Big[\tfrac{1}{4}\,e\,e'\,\Sigma.\,L_2 + \tfrac{1}{32}\,e\,e'\,(e^2 + e'^2)\,\Sigma.\,N_4 + \tfrac{1}{32}\,e\,e'^3\,O_4 + \tfrac{1}{8}\,e\,e'\,\lambda^2\,\Sigma.\,U_4\Big]^{(i+1)} \cos.\,(i\,l_0 + \varpi - \varpi') \\
& + \tfrac{1}{64}\,e^2 e'^2\,\Sigma^2.\,N_4^{(i+2)} \cos.\,(i\,l_0 + 2\,\varpi - 2\,\varpi') + \tfrac{1}{16}\,e^2\,\lambda^2\,Q_4^{(i+1)} \cos.\,(i\,l_0 + 2\,\varpi - 2\,\theta_0) \\
& - \tfrac{1}{8}\,e\,e'\,\lambda^2\,\Sigma.Q_4^{(i)} \cos.\,(i\,l_0 + \varpi + \varpi' - 2\,\theta_0) + \tfrac{1}{16}\,e'^2\,\lambda^2\,\Sigma^2\,Q_4^{(i-1)} \cos.\,(i\,l_0 + 2\,\varpi' - 2\,\theta_0) \\
& - \Big[\tfrac{1}{2}\,e\,K + \tfrac{1}{16}\,e^3\,\Sigma'.\,L_3 + \tfrac{1}{8}\,e\,e'^2\,\Sigma.\,L_3 + \tfrac{1}{384}\,e^5\,N_5 + \tfrac{1}{64}\,e^3\,e'^2\,\Sigma.\,\Sigma'.\,N_5 + \tfrac{1}{128}\,e\,e'^4\,\Sigma^2\,\Sigma'^2.\,N_5 \\
& - \tfrac{1}{4}\,e\,\lambda^2\,P_3 - \tfrac{1}{32}\,e^3\,\lambda^2\,X_5 - \tfrac{1}{16}\,e'^2\,e\,\lambda^2\,\Sigma.\,\Sigma'.\,X_5 + \tfrac{3}{16}\,e\,\lambda^4\,\mathbf{D}_5\Big]^{(i)} \cos.\,(i\,l_0 + l - \varpi)
\end{aligned}$$

$$+\Big[\tfrac{1}{2}\,e'\,\Sigma\,.\,K+\tfrac{1}{16}\,e'^3\,\Sigma^2.\,L_3+\tfrac{1}{8}\,e^2\,e'\,\Sigma\,.\,\Sigma'.\,L_3+\tfrac{1}{128}\,e^4\,e'\,\Sigma\,.\,N_5+\tfrac{1}{64}\,e^2\,e'^3\,\Sigma^2.\,\Sigma'.\,N_5+\tfrac{1}{384}\,e'^5\,\Sigma^3\,\Sigma'^2.\,N_5$$

$$-\tfrac{1}{4}\,e'\,\lambda^2\,\Sigma\,.\,P_3-\tfrac{1}{16}\,e^2\,e'\,\lambda^2\,\Sigma\,.\,X_5-\tfrac{1}{32}\,e'^3\,\lambda^2\,\Sigma\,.\,\Sigma'.\,X_5+\tfrac{3}{16}\,e'\,\lambda^4\,\Sigma\,.\,\mathbf{D}_5\Big]^{(i+1)}\cos.\,(i\,l_0+l-\varpi')$$

$$+\Big[\tfrac{1}{16}\,e^2\,e'\,L_3+\tfrac{1}{192}\,e^4\,e'\,\Sigma'.\,N_5+\tfrac{1}{128}\,e'^3\,e^2\,\Sigma\,.\,\Sigma'^2.\,N_5-\tfrac{1}{32}\,e^2\,e'\,\lambda^2\,\Sigma'.\,X_5\Big]^{(i-1)}\cos.\,(i\,l_0+l+\varpi'-2\,\varpi)$$

$$-\Big[\tfrac{1}{16}\,e\,e'^2\,\Sigma^2.\,\Sigma'.\,L_3+\tfrac{1}{128}\,e^3\,e'^2\,\Sigma^2.\,N_5+\tfrac{1}{192}\,e\,e'^4\,\Sigma^3.\,\Sigma'.\,N_5-\tfrac{1}{32}\,e\,e'^2\,\lambda^2\,\Sigma^2.\,X_5\Big]^{(i+2)}\cos.\,(i\,l_0+l+\varpi-2\,\varpi')$$

$$-\tfrac{1}{384}\,e^3\,e'^2\Sigma'^2.\,N_5^{(i-2)}\cos.\,(i\,l_0+l+2\,\varpi'-3\,\varpi)+\tfrac{1}{384}\,e^2\,e'^3\,\Sigma^3.\,N_5^{(i+3)}\cos.\,(i\,l_0+l-3\,\varpi'+2\varpi)$$

$$-\Big[\tfrac{1}{4}\,e\,\lambda^2\,O_3+\tfrac{1}{32}\,e^3\,\lambda^2\,\Sigma^2.\,\Sigma'.\,U_5+\tfrac{1}{16}\,e'^2\,e\,\lambda^2\,\Sigma\,.U_5-\tfrac{3}{8}\,e\,\lambda^4\,\Sigma'.\,\mathbf{B}_5\Big]^{(i+1)}\cos.\,(i\,l_0+l+\varpi-2\,\theta_0)$$

$$+\Big[\tfrac{1}{4}\,e'\,\lambda^2\,\Sigma\,.O_3+\tfrac{1}{32}\,e'^3\,\lambda^2\,U_5+\tfrac{1}{16}\,e^2\,e'\,\Sigma\,.\,\Sigma'.\,U_5-\tfrac{3}{8}\,e'\,\lambda^4\,\Sigma\,.\,\Sigma'.\,\mathbf{B}_5\Big]^{(i)}\cos.\,(i\,l_0+l+\varpi'-2\,\theta_0)$$

$$-\tfrac{1}{32}\,e\,e'^2\,\lambda^2\,\Sigma'\,U_5^{(i-1)}\cos.\,(i\,l_0+l+2\,\varpi'-\varpi-2\,\theta_0)$$

$$+\tfrac{1}{32}\,e^2\,e'\,\lambda^2\,\Sigma^2.\,U_5^{(i+2)}\cos.\,i\,l_0+l+2\,\varpi-\varpi'-2\,\theta_0)$$

$$-\tfrac{1}{96}\,e^3\,\lambda^2\,R_5^{(i-1)}\cos.\,(i\,l_0+l-3\,\varpi+2\,\theta_0)$$

$$+\tfrac{1}{32}\,e^2\,e'\,\lambda^2\,\Sigma\,.\,R_5^{(i)}\cos.\,(i\,l_0+l-2\,\varpi-\varpi'+2\,\theta_0)$$

$$-\tfrac{1}{32}\,e\,e'^2\,\lambda^2\,\Sigma^2.\,R_5^{(i+1)}\cos.\,(i\,l_0+l-\varpi-2\,\varpi'+2\,\theta_0)$$

$$+\tfrac{1}{96}\,e'^3\,\lambda^2\,\Sigma^3.\,R_5^{(i+2)}\cos.\,(i\,l_0+l-3\,\varpi'+2\,\theta_0)$$

$$+\Big[\tfrac{1}{8}\,e^2\,K_2+\tfrac{1}{32}\,e^2\,e'^2\,\Sigma\,.\,\Sigma'.\,L_4+\tfrac{1}{96}\,e^4\,L_4-\tfrac{1}{16}\,e^2\,\lambda^2\,T_4\Big]^{(i)}\cos.\,(i\,l_0+2\,l-2\,\varpi)$$

$$-\Big[\tfrac{1}{4}\,e\,e'\,\Sigma\,.\,K_2+\tfrac{1}{32}\,e^3\,e'\,\Sigma\,.\,L_4+\tfrac{1}{32}\,e\,e'^3\,\Sigma^2.\,\Sigma'\,.\,L_4-\tfrac{1}{8}\,e\,e'\,\lambda^2\,\Sigma\,.\,T_4\Big]^{(i+1)}\cos.\,(i\,l_0+2\,l-\varpi-\varpi')$$

$$+\Big[\tfrac{1}{8}\,e'^2\,\Sigma^2.\,K_2+\tfrac{1}{32}\,e^2\,e'^2\,\Sigma^2.\,L_4+\tfrac{1}{96}\,e'^4\,\Sigma^3.\,\Sigma'.\,L_4-\tfrac{1}{16}\,e'^2\,\lambda^2\,\Sigma^2.\,T_4\Big]^{(i+2)}\cos.\,(i\,l_0+2\,l-2\,\varpi')$$

$$-\tfrac{1}{96}\,e^3\,e'\,\Sigma'.\,L_4^{(i-1)}\cos.\,(i\,l_0+2\,l+\varpi'-3\,\varpi)-\tfrac{1}{96}\,e\,e'^3\,\Sigma^3.\,L_4^{(i+3)}\cos.\,(i\,l_0+2\,l-3\,\varpi'+\varpi)$$

$$+\Big[\tfrac{1}{2}\,\lambda^2\,\alpha\,b_{\frac{3}{2}}+\tfrac{1}{8}\,e^2\,\lambda^2\,R_4+\tfrac{1}{8}\,e'^2\,\lambda^2\,R_4^{(-1)}-\tfrac{3}{4}\,\lambda^4\,\alpha^2\,g_{\frac{5}{2}}\Big]^{(i+1)}\cos.\,(i\,l_0+2\,l-2\,\theta_0)$$

$$-\tfrac{1}{8}\,e\,e'\,\lambda^2\Big[R_4^{(-1)}-S_4+16\,\alpha\,b_{\frac{3}{2}}\Big]^{(i+2)}\cos.\,(i\,l_0+2\,l+\varpi-\varpi'-2\,\theta_0)$$

$$-\tfrac{1}{8}\,e\,e'\,\lambda^2\,(R_4+S_4)^{(i)}\cos.\,(i\,l_0+2\,l+\varpi'-\varpi-2\,\theta_0)$$

$$-\Big[\tfrac{1}{48}\,e^3\,K_3+\tfrac{1}{768}\,e^5\,L_5+\tfrac{1}{192}\,e^3\,e'^2\,\Sigma\,.\,\Sigma'\,.\,L_5-\tfrac{1}{96}\,e^3\,\lambda^2\,W_5\Big]^{(i)}\cos.\,(i\,l_0+3\,l-3\,\varpi)$$

$$+\Big[\tfrac{1}{16}\,e^2\,e'\,\Sigma\,.\,K_3+\tfrac{1}{192}\,e^4\,e'\,\Sigma\,.\,L_5+\tfrac{1}{128}\,e^2\,e'^3\,\Sigma^2.\,\Sigma'.\,L_5-\tfrac{1}{32}\,e^2\,e'\,\lambda^2\,\Sigma\,.\,W_5\Big]^{(i+1)}\cos.\,(i\,l_0+3\,l-2\,\varpi-\varpi')$$

$$-\Big[\tfrac{1}{16}\,e\,e'^2\,\Sigma^2.\,K_3+\tfrac{1}{192}\,e\,e'^4\,\Sigma^3.\,\Sigma'.\,L_5+\tfrac{1}{128}\,e^3\,e'^2\,\Sigma^2.\,L_5-\tfrac{1}{32}\,e\,e'^2\,\Sigma^2.\,W_5\Big]^{(i+2)}\cos.\,(i\,l_0+3\,l-\varpi-2\,\varpi)$$

$$+\Big[\tfrac{1}{48}\,e'^3\,\Sigma^3.\,K_3+\tfrac{1}{768}\,e'^5\,\Sigma^4.\,\Sigma'.\,L_5+\tfrac{1}{192}\,e^2\,e'^3\,\Sigma^3.\,L_5-\tfrac{1}{96}\,e'^3\,\lambda^3\,\Sigma^3.\,W_5\Big]^{(i+3)}\cos.\,(i\,l_0+3\,l-3\,\varpi')$$

$$+\tfrac{1}{768}\,e^4\,e'\,\Sigma'.\,L_5^{(i-1)}\cos.\,(i\,l_0+3\,l+\varpi'-4\,\varpi)-\tfrac{1}{768}\,e'^4\,e\,\Sigma^4.\,L_5^{(i+4)}\cos.\,(i\,l_0+3\,l+\varpi-4\,\varpi')$$

$$-\Big[\tfrac{1}{4}\,e\,\lambda^2\,N_3+\tfrac{1}{32}\,e^3\,\lambda^2\Sigma'.\,S_5+\tfrac{1}{16}\,e\,e'^2\,\lambda^2\,\Sigma\,.\,S_4-\tfrac{3}{8}\,e\,\lambda^4\,\mathbf{B}_5\Big]^{(i+1)}\cos.\,(i\,l_0+3\,l-\varpi-2\,\theta_0)$$

$$+\Big[\tfrac{1}{4}\,e'\,\lambda^2\,\Sigma\,.\,N_4+\tfrac{1}{32}\,e'^3\,\lambda^2\,\Sigma^2.\,S_5+\tfrac{1}{16}\,e^2\,e'\,\lambda^2\,\Sigma\,.\,\Sigma'.\,S_5-\tfrac{3}{8}\,e'\,\lambda^4\,\Sigma\,.\,\mathbf{B}_5\Big]^{(i+2)}\cos.\,(i\,l_0+3\,l-\varpi'-2\,\theta_0)$$

$$+\tfrac{1}{32}\,e^2\,e'\,\lambda^2\,S_5^{(\,)}\cos.\,(i\,l_0+3\,l+\varpi'-2\,\varpi-2\,\theta_0)-\tfrac{1}{32}\,e\,e'^2\,\lambda^2\,\Sigma^2.\,\Sigma'.\,S_5^{(i+3)}\cos.\,(i\,l_0+3\,l+\varpi-2\,\varpi'-2\,\theta_0)$$

$$-\tfrac{3}{16}\,e\,\lambda^4\,\Sigma'.\,Z_5^{(i+2)}\cos.\,(i\,l_0+3\,l+\varpi-4\,\theta_0)+\tfrac{3}{16}\,e'\,\lambda^4\,\Sigma.\,\Sigma'.\,Z_5^{(i+1)}\cos.\,(i\,l_0+3\,l+\varpi'-4\,\theta_0)$$

$$+\tfrac{1}{384}\,e^4\,K_4^{(i)}\cos.\,(i\,l_0+4\,l-4\,\varpi)-\tfrac{1}{96}\,e^3\,e'\,\Sigma.\,K_4^{(i+1)}\cos.\,(i\,l_0+4\,l-3\,\varpi-\varpi')$$

$$+\tfrac{1}{64}\,e^2\,e'^2\,\Sigma^2.\,K_4^{(i+2)}\cos.\,(i\,l_0+4\,l-2\,\varpi-2\,\varpi')-\tfrac{1}{96}\,e\,e'^3\,\Sigma^3.\,K_4^{(i+3)}\cos.\,(i\,l_0+4\,l-\varpi-3\,\varpi')$$

$$+\tfrac{1}{384}\,e'^4\,\Sigma^4.\,K_4^{(i+4)}\cos.\,(i\,l_0+4\,l-4\,\varpi')+\tfrac{1}{16}\,e^2\,\lambda^2\,P_4^{(i+1)}\cos.\,(i\,l_0+4\,l-2\,\varpi-2\,\theta_0)$$

$$-\tfrac{1}{8}\,e\,e'\,\lambda^2\,\Sigma.\,P_4^{(i+2)}\cos.\,(i\,l_0+4\,l-\varpi-\varpi'-2\,\theta_0)+\tfrac{1}{16}\,e'^2\,\lambda^2\,\Sigma^2.\,P_4^{(i+3)}\cos.\,(i\,l_0+4\,l-2\,\varpi'-2\,\theta_0)$$

$$+\tfrac{3}{8}\,\lambda^4\,\alpha^2\,b_{\frac{5}{2}}^{(i+2)}\cos.\,(i\,l_0+4\,l-4\,\theta_0)-\tfrac{1}{3840}\,e^5\,K_5^{(i)}\cos.\,(i\,l_0+5\,l-5\,\varpi)$$

$$+\tfrac{1}{768}\,e^4\,e'\,\Sigma.\,K_5^{(i+1)}\cos.\,(i\,l_0+5\,l-4\,\varpi-\varpi')-\tfrac{1}{384}\,e^3\,e'^2\,\Sigma^2.\,K_5^{(i+2)}\cos.\,(i\,l_0+4\,l-3\,\varpi-2\,\varpi')$$

$$+\tfrac{1}{384}\,e^2\,e'^3\,\Sigma^3.\,K_5^{(i+3)}\cos.\,(i\,l_0+5\,l-2\,\varpi-3\,\varpi')-\tfrac{1}{768}\,e\,e'^4\,\Sigma^4.\,K_5^{(i+4)}\cos.\,(i\,l_0+5\,l-\varpi-4\,\varpi')$$

$$+\tfrac{1}{3840}\,e'^5\,\Sigma^5.\,K_5^{(i+5)}\cos.\,(i\,l_0+5\,l-5\,\varpi')-\tfrac{1}{96}\,e^3\,\lambda^2\,Q_5^{(i+1)}\cos.\,(i\,l_0+5\,l-3\,\varpi-2\,\theta_0)$$

$$+\tfrac{1}{32}\,e^2\,e'\,\lambda^2\,\Sigma.\,Q_5^{(i+2)}\cos.\,(i\,l_0+5\,l-2\,\varpi-\varpi'-2\,\theta_0)-\tfrac{1}{32}\,e\,e'^2\,\lambda^2\,\Sigma^2.\,Q_5^{(i+3)}\cos.\,(i\,l_0+5\,l-\varpi-2\,\varpi'-2\,\theta_0)$$

$$+\tfrac{1}{96}\,e'^3\,\lambda^2\,\Sigma^3.\,Q_5^{(i+4)}\cos.\,(i\,l_0+5\,l-3\,\varpi'-2\,\theta_0)-\tfrac{3}{16}\,e\,\lambda^4\,Z_5^{(i+2)}\cos.\,(i\,l_0+5\,l-\varpi-4\,\theta_0)$$

$$+\tfrac{3}{16}\,e'\,\lambda^4\,\Sigma.\,Z_5^{(i+3)}\cos.\,(i\,l_0+5\,l-\varpi'-4\,\theta_0).$$

The fractional indices in this formula, which are annexed to the parentheses, are to be distributed to each fraction in the parenthesis; but in the especial case of $R^{(-1)}$, the exponent indicates that the sign of the index is to be reversed.

In this formula all integral values are to be given to i, from positive to negative infinity, including zero.

In the case of the action of an outer upon an inner planet $b_{\frac{1}{2}}^{(1)}$, $\alpha\ D_\alpha\ b_{\frac{1}{2}}^{(1)}$ and $\frac{1}{2}\,\alpha\,b_{\frac{3}{2}}^{(0)}$ must each of them be diminished by α.

In the case of the action of an inner upon an outer planet, $b_{\frac{1}{2}}^{(1)}$ must be diminished by α^{-2}, and each of its differential coefficients must be affected with the corresponding diminution; and in the same way $b_{\frac{3}{2}}^{(0)}$ must be diminished by $2\,\alpha^{-3}$ and its coefficients must experience the corresponding diminution; that is,

$$D_\alpha^n\,.\,b_{\frac{1}{2}}^{(1)} \text{ must be diminished by } D_\alpha^n\,.\,\alpha^{-2},$$

and

$$D_\alpha^n\,.\,b_{\frac{3}{2}}^{(0)} \text{ must be diminished by } 2\,D_\alpha^n\,.\,\alpha^{-3}.$$

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ADVERTISEMENT.

THE

ASTRONOMICAL JOURNAL

No. 2.

VOL. I. CAMBRIDGE, DECEMBER 13, 1849. NO. 2.

Extract from a Letter of Professor J. S. Hubbard, of the Washington Observatory, to the Editor.

Observatory, Washington City, November 6, 1849.

I send herewith the zodiac of Hygea. It is computed from D'Arrest's second elements (*Astr. Nachr.*, No. 680), which appear to possess sufficient accuracy for this purpose.* It has been already remarked by Mr. Luther (*Astr. Nachr.*, No. 676), that the moving star of Cacciatore could not be identical with this planet, an inference drawn from consideration of the period of revolution. Since the position given by Cacciatore occurs only in three of the zodiacs, that of Pallas, of Iris, and of Hygea, and since it could have been neither of these for other reasons, it follows that, if this star were indeed an asteroid, it yet remains to be re-discovered.

The planet Hygea can be seen in the northern limit of its zodiac, only between Sept. 19 and Oct. 27, and in the southern limit, between March 22 and April 28.

J. S. HUBBARD.

* This zodiac is intended as a continuation of the list delivered by me to the Smithsonian Institution, in Nov. 1848, and whose publication has been delayed by unavoidable circumstances.

ZODIAC OF HYGEA.

α	δ North Limit.	δ South Limit.	α	δ North Limit.	δ South Limit.	α	δ North Limit.	δ South Limit.
0°	+ 5° 44′	+ 2° 59′	120°	+ 21° 3′	+ 18° 27′	240°	− 22° 9′	− 25° 14′
5	7 58	5 16	125	19 40	17 0	245	22 46	25 50
10	10 7	7 29	130	18 9	15 26	250	23 13	26 16
15	12 10	9 36	135	16 29	13 42	255	23 30	26 32
20	14 8	11 37	140	14 41	11 49	260	23 36	26 38
25	15 58	13 30	145	12 44	9 49	265	23 33	26 34
30	17 40	15 14	150	10 41	7 42	270	23 17	26 19
35	19 13	16 49	155	8 32	5 29	275	22 53	25 54
40	20 38	18 15	160	6 19	3 11	280	22 18	25 19
45	21 54	19 31	165	4 2	+ 0 52	285	21 33	24 34
50	23 0	20 38	170	+ 1 43	− 1 28	290	20 39	23 39
55	23 56	21 35	175	− 0 35	3 49	295	19 35	22 34
60	24 42	22 22	180	2 53	6 8	300	18 21	21 20
65	25 18	22 59	185	5 8	8 24	305	16 58	19 56
70	25 44	23 25	190	7 20	10 37	310	15 25	18 23
75	26 0	23 41	195	9 26	12 43	315	13 43	16 40
80	26 7	23 47	200	11 26	14 43	320	11 53	14 49
85	26 3	23 43	205	13 18	16 34	325	9 56	12 51
90	25 51	23 28	210	15 3	18 17	330	7 52	10 46
95	25 27	23 4	215	16 38	19 50	335	5 43	8 35
100	24 54	22 29	220	18 3	21 14	340	3 29	6 20
105	24 11	21 44	225	19 19	22 28	345	− 1 12	4 2
110	23 18	20 49	230	20 25	23 33	350	+ 1 7	− 1 41
115	22 15	19 43	235	21 22	24 28	355	3 26	+ 0 10
120	+ 21 3	+ 18 27	240	− 22 9	− 25 14	630	+ 5 44	+ 2 59

ON THE ORBIT OF THE GREAT COMET OF 1843.

By PROFESSOR J. S. HUBBARD,

OF THE WASHINGTON OBSERVATORY.

§ 1.

ALTHOUGH nearly seven years have elapsed since the appearance of this remarkable comet, we have as yet no complete discussion of the observations made upon it, and consequently no well-grounded theory respecting the nature of its orbit. Several reasons may be assigned for this neglect. The comet was visible for only a few days; and although during these few days every telescope was directed towards it, yet the shortness of time, the small apparent motion of the comet, and its proximity to the horizon, afforded but slight hope of an accurate determination of its orbit. It is not strange that, under such circumstances, very different results were obtained by different computers, or that, even with the best orbits, large errors of observation should appear, obstinately refusing any reconciliation with theory, and seeming to render hopeless all attempts at farther accuracy. And besides these discouragements existing in the nature of the case, it is probable that the discovery, in November of the same year, of the comet of FAYE, in some respects more interesting, may have contributed to divert the attention of astronomers from the one now under consideration.

The difficulties attending the investigation of the orbit of this comet may, perhaps, be best illustrated by a consideration of some of the results obtained by various computers. At the outset, recourse was naturally had to the parabolic hypothesis. The first thing that excited remark was the smallness of the perihelion distance. The discrepancies in this, which, however, in most cases would not be surprising, here became noticeable, since, in some instances, a distance was assigned less than the radius of the sun itself; a result which can only be attributed to the use of erroneous data. With regard to the position of the orbit in reference to the ecliptic, a general agreement was soon arrived at among astronomers, but the existence of an ellipticity has not yet been satisfactorily established. The failure of parabolic elements to represent the apparent motion of the comet, a failure mainly due, however, to the uncertainty of observations, increased the hope of obtaining an ellipse, and of identifying the still unknown stranger with some former visiter. In its small perihelion distance, the comet bore resemblance to that of 1680; in its physical phenomena, to that of 1668, and to several others, of which accounts more or less vague are to be found in our cometographies. Assuming the identity of the present comet with that of 1668, LAUGIER and MAUVAIS, NICOLAI and GOULD obtained elements which represented quite closely the present observed positions, and HENDERSON's computations gave nearly the positions on the map of ÆGIDIUS. The Paris astronomers also assumed a period of 35 years, examining the chances of identity with certain other comets, but with less success in representing the phenomena. Professor PEIRCE computed two orbits, each with an assumed period of $21\frac{7}{8}$ years, — requiring the one to satisfy a daylight observation of Feb. 28, and the other a similar observation of Feb. 27. The first orbit of the two gave a better result than the Paris ellipse of 35 years; the second was less satisfactory. Performing the computations independently of any hypothesis, GOULD obtained a period of $189\frac{1}{2}$ years, highly confirmatory of his previous result, while the calculations of CAPOCCI and CLAUSEN gave a period of only 7 years. On the other hand, ENCKE, WALKER, and ANDERSON obtained, by the same general method, hyperbolic elements which followed the observations closely, and, being founded on normals, seemed deserving of great confidence. Mr. WALKER, however, expressed his opinion in favor of an ellipse of $21\frac{7}{8}$ years. Finally, BOGUSLAWSKI contends for a period of $147\frac{1}{3}$ years, as being the most probable inference to be drawn from cometography. (1)

The above recapitulation will sufficiently show that great room has been left for doubt respecting the true nature and dimensions of the orbit of this remarkable comet. It is the object of the present discussion, to endeavor to remove some of the remaining uncertainty, and to determine the true orbit, so far as is practicable, from observations alone. The historical part of the investigation comes properly after this.

The comet was first seen on the 27th of February, at 11 o'clock, A. M., by Captain RAY, at Conception, S. A. "Its distance from the sun was only 5′ or one sixth of the sun's apparent diameter. 'He did not,' says WILLIAM MITCHELL, of Nantucket, 'measure the angle, — but he took great pains to estimate the apparent distance.'" (2) On the 28th, it was observed by Captain CLARKE, of Portland, Me., as follows: (3) —

At 3h.	2m.	15s.	P. M.,	Sun's	farthest	limb	from	nearest	limb of nucleus	=	4°	6′	15″
3	6	20	"	"	"	"	"	farthest	" " "	=	4	7	30
3	9	40	"	"	"	"	"	extremity of tail		=	5	6	30.

(1) *Astr. Nachr.*, No. 545, and *Report of British Association for* 1845.

(2) *American Almanac*, 1844, p. 94.

(3) *American Journal of Science*, Vol. XLV. p. 229.

On the same day, it was observed by Mr. Bowring at Chihuahua in Mexico. He gives the following: (1) —

At 1h.	2m.	53s..5 P. M.,	Double altitude of Comet	= 101°	1′ 00″	mean of	5 obs.
2	2	27 .0 "	" " " "	= 84	41 27	" "	3 "
2	10	37 .0 "	" " " Sun	= 79	0 14	" "	5 "

Mr. Bowring adds, — "L'erreur du sextant était de +40 secondes et la montre avait une marche assez régulière de $-1^{m.}\ 15^{s.}$ par jour."

At 4h. 12m. P. M., the distance from the Sun = 3° 53′ 20″.

The comet was also seen on the 28th, by a multitude of persons in this country, in Europe, and throughout the southern hemisphere, and on the evening of each succeeding day, for a month, its magnificent train excited the wonder and admiration of countless numbers. The first published observations after the 28th of February, which are of value, were made by Mr. Caldecott, at Trevandrum, his first date being the 6th of March.* Observations were also taken at the same time at the Cape of Good Hope, but I have been unable to find them in any publication. The next observers in the order of time were Loomis at Hudson, and Walker and Kendall at Philadelphia. At both of these places, the nucleus was observed on the 11th of March. On the 17th it was observed at New Haven, Rome, and Naples, and each succeeding night during the month contributed largely to the list of observations. After the 1st of April, the comet began to disappear, and on the 9th and 10th was observed at Philadelphia alone. On the 15th, Encke succeeded in obtaining an observation; while at Hamburg on the same evening its position was rather suspected than seen. (2)

(1) *Comptes Rendus*, XVII. p. 85.

* The mean time of the first observation is given incorrectly in the *Astr. Nachr.*, No. 495. It should be $7^{h.}\ 4^{m.}\ 35^{s.}.30$. Compare *Ast. Soc. Notices*, V. p. 303.

(2) *Astr. Nachr.*, No. 487.

§ 2.

The following list contains all the observations I have been able to collect. There are yet wanting those made at the Cape of Good Hope, at Hamburg, at Breslau, and probably at other places. The Paris astronomers have given the comparison of their observations with theory, but, except in two cases, with the unfortunate omission of the observations themselves. For the series made at New Haven, and which have not yet been published, I am indebted to the kindness of the observer, Mr. Francis Bradley. All the positions given below have been corrected for parallax, and the times for aberration, excepting in the Hudson observations, which had been already corrected for parallax by Professor Loomis.

Date, M. T Berlin.	Place.	α	δ	References.
March 6d.11335	Trevandrum,	8° 29′ 16″.3	−11° 57′ 58″.6	Ast. Soc. Notices, V. p. 303.
8 .10630	"	15 11 24.8	12 7 20.0	" " "
9 .10204	"	18 27 20.0	12 0 41.9	" " "
10 .10361	"	21 35 40.7	11 51 34.9	" " "
11 .09873	"	24 31 59.8	41 44.8	" " "
.54740	Philadelphia,	25 53 45.0	35 23.0	Astr. Nachr., No. 480.
.58129	Hudson,	25 57 45.0	35 10.0	Trans. of Am. Phil. Soc., IX.
13 .11386	Trevandrum,	30 7 56.6	15 17.9	Ast. Soc. Notices, V. p. 303.
14 .10518	"	32 39 35.1	11 0 3.9	" " "
15 .11857	"	35 3 13.8	10 43 19.9	" " "
16 .09963	"	37 20 16.4	27 1.9	" " "
17 .09908	"	39 29 22.1	9 45.9	" " "
.32186	Rome,	57 36.8	5 53.6	Astr. Nachr., No. 478.
.33025	Naples,	39 58 40.2	5 30.0	" " " 494.
.55815	New Haven,	40 26 10.0	10 1 7.1	MS.
18 .10879	Trevandrum,	41 33 2.7	9 52 0.1	Ast. Soc. Notices, V. p. 303.
.30888	Naples,	37 13.0	48 24.1	Astr. Nachr., No. 494.
.32173	Rome,	56 47.8	50 58.8	" " " 474.
.32993	Geneva,	41 59 23.1	47 45.7	" " " 474.
.34843	Paris,	42 1 53.2	47 55.5	Comptes Rendus, XVI. p. 598.
.93948	Port Stephens,	43 9 58.7	38 41.2	Ast. Soc. Notices, VI. p. 8.
19 .11728	Trevandrum,	30 2.7	31 41.2	" " V. p. 303.
.25013	Nicolajew,	45 23.5	32 13.9	Astr. Nachr., No. 477.
.30687	Naples,	51 38.7	30 52.8	" " " 494.
.31074	Kremsmünster,	52 0.3	31 20.7	" " " 504.
.32100	Modena,	46 40.4	31 10.7	" " " 483.
.32392	Munich,	52 29.2	39 59.7	Ast. Soc. Notices, V. p. 288.
.32903	Geneva,	53 57.1	30 40.9	Astr. Nachr., No. 474.
.33877	Rome,	54 17.9	30 47.4	" " " 474.
.34805	Paris,	43 56 5.1	− 9 30 20.7	Comptes Rendus, XVI. p. 599.

Date, M. T. Berlin.	Place.	α	δ	References.
March 19d .54963	Philadelphia,	44° 18′ 36″.9	— 9° 26′ 51″.7	Astr. Nachr., No. 480.
.93642	Port Stephens,	45 0 39.9	20 1.2	Ast. Soc. Notices, VI. p. 8.
20 .30754	Cracow,	40 21.4	14 2.4	Astr. Nachr., No. 489.
.30879	Naples,	40 49.2	14 9.6	" " " 494.
.30993	Kremsmünster,	41 12.4	13 46.5	" " " 504.
.32145	Rome,	41 8.2	13 4.4	" " " 474.
.32378	Munich,	42 12.0	13 47.9	Ast. Soc. Notices, V. p. 288.
.32475	Modena,	42 7.6	13 9.8	Astr. Nachr., No. 483.
.32714	Berlin,	45 42 34.7	13 33.5	" " " 474.
.57079	New Haven,	46 8 10.6	9 8 24.0	MS.
21 .29783	Cracow,	47 23 35.6	8 56 12.8	Astr. Nachr., No. 489.
.30470	Kremsmünster,	23 25.1	57 19.7	" " " 504.
.30514	Naples,	23 25.8	57 9.6	" " " 494.
.31129	Vienna,	24 34.0	56 30.3	Wiener Beobb., XXII. p. lxi.
.32364	Munich,	24 58.9	57 16.5	Ast. Soc. Notices, V. p. 288.
.32455	Geneva,	25 24.4	56 44.1	Astr. Nachr., No. 474.
.32700	Berlin,	25 34.5	56 33.7	" " " 474.
.32974	Mannheim,	25 48.7	56 41.1	" " " 475.
.34201	Bonn,	27 27.8	56 43.8	" " " 475.
.57579	New Haven,	49 48.9	51 47.1::	MS.
.59849	Hudson,	47 51 50.1	52 33.8	Trans. of Am. Phil. Soc., IX.
22 .27057	Nicolajew,	48 57 59.0	40 49.1	Astr. Nachr., No. 477.
.29615	Vienna,	49 0 44.8	40 15.9	Wiener Beobb., XXII. p. lxi.
.29619	Cracow,	1 28.6	41 4.7	Astr. Nachr., No. 489.
.31326	Munich,	2 50.5	40 13.1	Ast. Soc. Notices, V. p. 288.
.31343	Kremsmünster,	1 32.3	40 29.1	Astr. Nachr., No. 504.
.31658	Naples,	2 24.0	39 48.0	" " " 494.
.32685	Berlin,	3 31.9	39 53.7	" " " 474.
.56369	Philadelphia,	26 9.9	35 59.8	" " " 480.
.92097	Port Stephens,	49 59 12.1	30 21.4	Ast. Soc. Notices, VI. p. 8.
23 .30575	Cracow,	50 35 51.7	21 41.7	Astr. Nachr., No. 489.
.31775	Kremsmünster,	35 26.7	23 11.6	" " " 504.
.32639	Munich,	36 34.7	22 58.3	Ast. Soc. Notices, V. p. 288.
.55884	Philadelphia,	50 57 33.1	19 16.5	Astr. Nachr., No. 480.
24 .30271	Cracow,	52 3 48.3	8 42.9	" " " 489.
.32061	Padua,	4 33.3	7 34.3	" " " 479 and 484.
.32654	Berlin,	5 2.9	7 21.7	" " " 474.
.54954	Philadelphia,	52 24 9.0	8 3 42.3	" " " 480.
25 .26734	Nicolajew,	53 24 23.8	7 52 38.0	" " " 477.
.32639	Berlin,	29 21.2	51 40.9	" " " 474.
.33067	Prague,	29 47.3	53 57.2	" " " 474.
.34954	Mannheim,	30 55.9	52 1.1	" " " 475.
.35114	Bonn,	31 25.9	51 8.9	" " " 475.
.35814	Hamburg,	34 38.0	52 23.4	" " " 477.
.59183	Hudson,	53 50 58.2	48 2.4	Trans. of Am. Phil. Soc., IX.
26 .11046	Trevandrum,	54 31 55.2	39 10.5	Ast. Soc. Notices, V. p. 303.
.31016	Cracow,	50 15.0	37 36.9::	Astr. Nachr., No. 489.
.31667	Königsberg,	48 29.2	36 18.1	" " " 474.
.32624	Berlin,	54 49 37.0	36 22.0	" " " 474.
.55571	Philadelphia,	55 7 27.0	32 22.3	" " " 480.
27 .30351	Naples,	56 4 32.9	21 46.8	" " " 494.
.31154	Königsberg,	5 29.0	21 50.3	" " " 474.
.31833	Cracow,	6 22.8	. . .	" " " 489.
.32608	Berlin,	6 24.5	21 19.8	" " " 474.
.33296	Rome,	56 6 51.4	22 1.0	" " " 478.
28 .31029	Naples,	57 19 13.2:	7 22.7:	" " " 494.
.32072	Cracow,	20 44.1	7 55.7	" " " 489.
32592	Berlin,	19 51.1	6 59.0	" " " 474.
.34533	Bonn,	57 21 10.5	7 7 1.8	" " " 475.
.94512	Port Stephens,	58 3 17.5	6 59 39.2	Ast. Soc. Notices, VI. p. 8.
29 .30667	Naples,	29 40.5	52 30.2	Astr. Nachr., No. 494.
.31225	Cracow,	58 28 56.9	— 6 50 50.7	" " " 489.

Date, M. T. Berlin.	Place.	α	δ	References.
March 29d.31927	Königsberg,	58° 29′ 59″.8	— 6° 52′ 19″.5	Astr. Nachr., No. 477.
.32576	Berlin,	30 7.8	52 57.6	" " " 474.
.33550	Modena,	30 36.1	53 35.7	" " " 483.
.33815	Prague,	30 55.7	54 8.2	" " " 478.
.34095	Padua,	31 41.9	53 23.3	" " " 479.
.34169	Bonn,	31 15.7	52 55.8	" " " 475.
.35116	Mannheim,	31 51.3	52 45.7	" " " 475.
.56789	New Haven,	58 45 57.3	. . .	MS.
30 .31796	Cracow,	59 38 19.0	. . .	Astr. Nachr., No. 489.
.32186	Modena,	36 49.3	39 57.8	" " " 483.
.32206	Naples,	36 56.6	39 45.3	" " " 494.
.32556	Berlin,	37 13.7	39 39.9	" " " 474.
.32857	Kremsmünster,	37 2.2	39 36.9	" " " 504.
.32938	Munich,	37 45.9	39 59.1	Ast. Soc. Notices, V. p. 288.
.33428	Rome,	37 40.8	39 52.6	Astr. Nachr., No. 478.
.33430	Prague,	38 19.4	39 48.7	" " " 478.
.33863	Mannheim,	38 26.4	. . .	" " " 475.
.33904	Geneva,	59 37 54.0	39 32.3	" " " 477.
31 .27835	Nicolajew,	60 39 3.1	27 0.6	" " " 477.
.31558	Naples,	41 2.4	26 31.4	" " " 494.
.31898	Vienna,	41 53.9	. . .	Wiener Beobb., XXII. p. lxii.
.32543	Berlin,	42 9.5	26 14.6	Astr. Nachr., No. 474.
.32631	Rome,	42 4.6	26 47.7	" " " 478.
.33253	Prague,	60 42 32.9	26 0.9	" " " 478.
April 1 .31615	Naples,	61 43 16.3	13 51.9	" " " 494.
.31766	Vienna,	44 3.5	13 18.8	Wiener Beobb., XXII. p. lxii.
.32203	Kremsmünster,	43 21.4	14 3.2	Astr. Nachr., No. 504.
.32469	Rome,	43 15.6	12 49.6	" " " 478.
.32489	Padua,	44 44.5	13 22.6	" " " 479.
.33830	Prague,	45 10.5	14 28.5	" " " 478.
.52986	Philadelphia,	61 58 39.0	. . .	" " " 480.
.59917	Hudson,	62 0 15.9	10 38.2	Trans. of Am. Phil. Soc., IX.
2 .32747	Kremsmünster,	43 35.0	1 8.6	Astr. Nachr., No. 504.
.33998	Padua,	45 2.2	6 1 9.1	" " " 479.
.56286	Philadelphia,	62 57 49.8	5 58 46.8	" " " 480.
3 .33503	Kremsmünster,	63 41 2.5	51 1.9	" " " 504.
5 .33643	Rome,	65 30 36.5	27 14.5	" " " 478.
.61548	Hudson,	65 45 34.0	23 47.5	Trans. of Am. Phil. Soc., IX.
6 .32136	Rome,	66 21 5.8	16 7.1	Astr. Nachr., No. 478.
.32604	Naples,	22 53.4	16 15.6	" " " 494.
.60332	Hudson,	66 36 26.4	12 57.8	Trans. of Am. Phil. Soc., IX.
7 .32930	Naples,	67 10 6.8	5 7 8.9	Astr. Nachr., No. 494.
.56484	Philadelphia,	67 23 27.7	. . .	" " " 480.
9 .56855	Philadelphia,	68 58 3.1	4 45 38.3	" " " 480.
10 .58489	Philadelphia,	69 45 15.0	4 36 38.0	" " " 480.
15 .32295	Berlin,	73 1 26.7	— 3 56 24.4	" " " 477.

(*To be continued.*)

ON THE VELOCITY OF THE ELECTRICAL WAVE OR CURRENT, THROUGH A METALLIC CIRCUIT.

By O. M. MITCHEL,

DIRECTOR OF THE CINCINNATI OBSERVATORY.

The machinery now in use in the Cincinnati Observatory, for the conversion of time into space, furnishes the means of executing the most delicate experiments in the record of minute fractions of time. The sidereal clock is made to record its

beats on a metallic disk, revolving beneath a steel recording pen fixed in position. The disk which carries the metal plate is made to revolve with uniform velocity, and receives the stroke of the recording pen without affecting its motion. A second pen, situated directly opposite the first, is placed under the control of the observer at the transit or other instrument, and gives him the means of recording any observed phenomenon with all the accuracy with which the eye can seize the instant of its occurrence.

On the completion of this machinery, several months since, my attention was called to the velocity of electrical currents in their passage along the telegraphic wires and through the ground, as being involved in the determination of differences of longitude by signals, transmitted telegraphically.

On the evening of the 12th November, a series of experiments was performed at the Observatory, to determine the velocity of the electrical wave in its passage along the telegraphic wires. The long circuit involved in these experiments was formed as follows: —

From the main battery in the O'Rielly telegraph office, Cincinnati, along one wire to the Observatory, a distance of one mile; thence, by the continuation of the same wire, to Pittsburg; thence, returning on a second wire, to the Observatory; thence, through the receiving magnet, to a ground wire; thence, one mile, through the ground, to the main battery in Cincinnati.

The following is the plan on which the experiments were conducted. The sidereal clock was so arranged that its pendulum closed a local circuit, operating on the *time pen* and recording the alternate clock-beats or seconds, on a metal plate placed on the revolving disk already described. This connection remained unchanged during the entire course of the experiments, and this pen is called hereafter the *standard pen*.

A receiving magnet was made to close a short local circuit (equal in power and length to the former), which operated on the *observation pen*, causing it to strike its point into the metal plate. This receiving magnet was operated on in two modes, at the pleasure of the experimenter, as follows: —

1. By a local circuit, which was closed by the metallic handle of the standard pen.

2. By the long circuit before described, passing to and from Pittsburg, a distance of six hundred and seven miles, along the wires.

By these connections, it will be seen that the clock-beats were directly recorded by the standard pen. They were also recorded by the *variable pen* (as I shall designate the second one), moved by the standard pen, closing either a short local circuit through the receiving magnet, or the long Pittsburg circuit, through the same receiving magnet, — this receiving magnet, as before stated, closing the local circuit operating on the variable pen.

The standard pen record was followed by the variable pen record, at an interval in time equal to the armature time of the standard pen, increased by the armature time of the receiving magnet, increased by the wave time of the fluid in passing through the short circuit and receiving magnet, this last being of course insensible. This statement applies when the variable pen is driven by the short local circuit.

When the long circuit operates on the receiving magnet, and through this on the variable pen, then the standard pen is followed by the variable pen at an interval identical with the preceding, increased by the time required by the electrical wave or current for traversing the wires six hundred and seven miles.

This statement is only true on the following conditions, viz.: —

1. The intensity of the local circuit and the long circuit must be reduced to equality.

2. The adjustment of the receiving magnet must be constant, and its pass must be reduced to a minimum.

These two conditions being fulfilled, in case the two pens are so adjusted to each other in position that a straight line joining any two corresponding dots struck by them on a disk at rest will pass through the center of the disk, then the interval between the records of the two pens driven by a short and long circuit, diminished by the interval between the records when the variable pen is driven by a short circuit, will exhibit the time occupied by the wave in traversing the distance of six hundred and seven miles through the wires.

I will now proceed to show the importance of fulfilling strictly these three conditions: —

1. To adjust to equality the intensity of the long and short circuits operating through the receiving magnet upon the variable pen.

2. To reduce the pass of the receiving magnet to a minimum, and to keep it unchanged.

3. To adjust the recording pens to exact radiation of records, the disk being quiescent.

To ascertain the effect of intensity and pass, the following experiments were performed. The connections having been made as above described, four circumferences of second-dots were recorded by the two pens, under the following circumstances: —

No. 1. The pass of the receiving magnet a minimum.

No. 2. The pass of the receiving magnet a maximum.

No. 3. The battery reduced to one half its former power, the pass a maximum.

No. 4. The reduced battery, the pass a minimum.

On circumference No. 1, — minimum pass, and strong battery, — the variable pen fell behind the standard pen $0^{s}.091$ on a mean of many measures. The uniformity of these records and the accuracy of the measures are best exhibited by the measures themselves I give as a specimen the first ten measures out of thirty: —

s. 0.091	s. 0.091	s. 0.092
0.092	0.091	0.091
0.090	0.090	Mean, 0.091
0.090	0.092	

On circumference No. 2, — maximum working pass, strong battery, — the same interval became $0^{s}.2628$.

Circumference No. 3, — battery reduced one half, maximum pass, — the same interval measured $0^{s}.310$.

Circumference No. 4, — weak battery, pass a minimum, — same interval measured $0^{s}.104$.

From these experiments it becomes manifest that the adjustment of the receiving magnet may give variations of record far greater than the anticipated value of wave time on the longest available circuit. It is farther shown, that the effect of different intensities is such as to entail an error so great as to render all experiments useless, from which this effect is not strictly eliminated.

Two difficulties were now to be overcome. The batteries must be reduced to equality, and the evidence of that equality must be obtained. The following plan was adopted to accomplish these objects. The handles of the recording pens are flexible, and vibrate at every stroke of the pen. Half the length of this vibration is the armature time, as I will show hereafter. Now the armature time was found to depend on the intensity of the currents which operated on the receiving magnet. The local battery was therefore increased or decreased in power until the armature time, as recorded by the two circuits, was identical in value; — the pen being so adjusted, that the primary dot was always followed by the second, or vibrating dot, which was distinctly recorded by the pen in every record made.

These difficulties being thus overcome, the pens were adjusted to produce radiating dots, the disk being quiescent. It was subsequently found that this adjustment was imperfect to eleven thousandths of a second of time on the greatest circumference recorded. The absolute space was laid off on all the remaining circumferences, and, being accurately measured, gives the required correction.

All the arrangements having been perfected, the local connections were placed in the care of Mr. Henry Twitchell, while it was assisted in the distant connections by Mr. Stager, of the O'Rielly telegraph office, Cincinnati.

The evening was fair and calm, warm for the season. Mr. Stager reported the line in admirable working order. The receiving magnet was adjusted to its minimum working pass, and the long and short circuit batteries were pronounced equal in strength, by the equality of the recorded armature times.

At $9^{h.}$ $58^{m.}$ the pens fell together on the metal plate, the variable pen being operated on by the long circuit. I watched the disk to see that the records were perfectly made. The dots came down in the most beautiful manner, and the record was engraved on the metal with exquisite delicacy. At the close of the first circumference of dots, occupying exactly sixty seconds, notice was given to change; and, at the word, the long circuit was thrown off, and the local short circuit took its place. This change was so skilfully accomplished by Mr. Stager, that not a second was lost.

In this way five complete circumferences were recorded, — three with the long, and two with the short circuit. The ear could sometimes with difficulty recognize the change from long to short; but after many trials it was found that this organ could not with certainty be relied on. The conversion of time into space on the disk gave us, however, the opportunity of bringing a high magnifying power to bear upon the reading of the delicate records.

Mr. Twitchell has completed all the measures with the instrument contrived by me for measuring small angular spaces. It can be read down to the thousandth of a second of time. The disk performed in the most admirable manner during the entire experiment, — the records radiating from its center, and demonstrating the uniformity of its motion.

I present the measures of circumferences No. 1 and 2, to exhibit the character of the records. The slight variations are due, doubtless, to want of absolute uniformity in the connections. The variations are, however, very slight, and disappear in the mean of a group of thirty observations. The measures follow.

Circ. No. 1. Measured Interval from Standard Pen to Variable Pen.	Circ. No. 2. Measured Interval from Standard Pen to Variable Pen.	Differences No. 1 — No. 2.	Correction for Non-radiation — Constant.	
			No. 1.	No. 2.
s. 0.055	s. 0.040	s. 0.015	s. 0.0110	s. 0.0145
0.050	0.039	0.011		
0.055	0.036	0.019		
0.054	0.040	0.014		
0.054	0.040	0.014		
0.056	0.039	0.017		
0.055	0.039	0.016		
0.054	0.040	0.014		
0.055	0.040	0.015		
0.055	0.041	0.014		
0.055	0.040	0.005		
0.056	0.038	0.018		
0.056	0.040	0.016		
0.057	0.038	0.019		
0.061	0.046	0.015		
0.060	0.041	0.019		
0.061	0.040	0.021		
0.060	0.040	0.020		
0.058	0.041	0.017		
0.058	0.040	0.018		
0.060	0.041	0.019		
0.059	0.041	0.018		
0.058	0.039	0.019		
0.057	0.040	0.017		
0.057	0.039	0.018		
0.058	0.039	0.019		
0.057	0 010	0.017		
0.060	0.040	0.020		
0.057	0.040	0.017		
0.056	0.040	0.016		
Mean, 0.0568	0.0399	0.01656		
0.0110	0.0145			
0.0458	0.0254			

The mean values of the intervals are as follows: —

		Correction for Non-radiation.	
No. 1, Long Circuit, interval	= 0.0568 —	0.0110 =	0.0458
No. 2, Short " "	= 0.0399 —	0.0145 =	0.0254
No. 3, Long " "	= 0.0633 —	0.0165 =	0.0468
No. 4, Short " "	= 0.0444 —	0.0195 =	0.0249
No. 5, Long " "	= 0.0682 —	0.0215 =	0.0467

From a comparison of these values we obtain: —

No. 1, Long Circuit,	= 0.0458
No. 2, Short "	= 0.0254
Wave time on 607 miles of wire	= 0.0204
No. 1	= 0.0458
No. 4	= 0.0249
Wave time	= 0.0209
No. 3	= 0.0468
No. 2	= 0.0254
Wave time	= 0.0214
No. 3	= 0.0468
No. 4	= 0.0249
Wave time	= 0.0219
No. 5	= 0.0467
No. 2	= 0.0254
Wave time	= 0.0213
No. 5	= 0.0467
No. 4	= 0.0249
Wave time	= 0.0218

Wave time on 607 miles of wire, as deduced from

No. 1 — No. 2	=	0.0204
No. 1 — No. 4	=	0.0209
No. 3 — No. 2	=	0.0214
No. 3 — No. 4	=	0.0219
No. 5 — No. 2	=	0.0213
No. 5 — No. 4	=	0.0218
Mean	=	0.02128

Cincinnati Observatory, 16th Nov., 1849.

Mean $\pm$ No. 1	=	0.00088
" $\pm$ No. 2	=	0.00038
" $\pm$ No. 3	=	0.00014
" $\pm$ No. 4	=	0.00064
" $\pm$ No. 5	=	0.00002
" $\pm$ No. 6	=	0.00052
Mean,	=	0.00043

That is, the mean difference from the mean amounts to 43 hundred-thousandths of a second of time.

The velocity deduced along the wires, in case the circuit is 607 miles in length, is 28524 miles per second.

At some future time, I hope to resume these investigations. It would be interesting to repeat these experiments at different hours of the day and night, at different seasons of the year, and through different media. May not the velocity through the ground vary with the direction of the current, — whether east and west, or north and south?

I place great confidence in these results, as every care was taken to eliminate all possible sources of error. Every magnet in use was in the observatory, and all the connections and adjustments were under my own eye.

The adjustment of the receiving magnet was unaltered during the experiment, and no change occurred for more than thirty minutes after the experiments were finished. Each of the pens recorded, in every instance, the armature time in the distance from the primary to the vibratory dot. One half this record was shown to be the armature time, as follows: —

The variable pen could not begin to descend until the standard pen was down. Hence, considering the armature time of the receiving magnet as insensible (as it was), with a short circuit the interval of the two records would be equal to the armature time of the standard pen. This interval, being measured, was found to be exactly one half the interval between the primary and vibratory dot of the standard pen.

The length of this article forbids me to go into further detail. In case further particulars are desired, it will give me pleasure to furnish them by correspondence, or by a farther publication.

O. M. MITCHEL.

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THE

ASTRONOMICAL JOURNAL.

No. 3.

VOL. I. CAMBRIDGE, JANUARY 7, 1850. NO. 3.

Letter of Lieut. Maury, U. S. N., Superintendent of the Washington Observatory, to the Editor.

National Observatory, November 21, 1849.

I have the pleasure of sending you a series of observations on Metis, made and reduced by Mr. James Ferguson, one of the assistants at this Observatory.

M. F. MAURY.

OBSERVATIONS OF METIS,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

[Corrected for refraction.]

1849. M. T. Washington.	No. of Comparisons.	Star of Comparison.	Planet — Star. Δα	Planet — Star. Δδ	Planet's apparent α	Planet's apparent δ
d. h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
Sept. 9 8 3 35.2	2	7724, B. A. C.	+ 0 24.14	+ 2 24.52	22 3 6.30	— 21 55 34.95
8 57 59.5	7	"	+ 0 22.30	+ 2 18.66	22 3 4.47	21 55 40.81
10 4 5.2	2	"	+ 0 19.60	+ 2 9.65	22 3 1.77	21 55 49.82
10 29 56.3	5	"	+ 0 16.92	+ 2 1.81	22 2 59.09	21 55 57.66
10 8 48 35.3	10	"	— 0 28.27	— 0 21.90	22 2 13.90	21 58 24.44
9 23 29.8	3	"	— 0 29.73	— 0 28.47	22 2 12.44	21 58 27.94
11 9 54 51.8	3	"	— 1 20.42	— 3 3.69	22 1 21.79	22 1 3.21
11 32 53.8	4	"	— 1 23.36	— 3 14.29	22 1 18.81	22 1 13.91
12 9 55 29.6	2	"	— 2 8.34	— 5 21.22	22 0 33.82	22 3 20.91
10 51 36.5	2	"	— 2 10.29	— 5 29.36	22 0 31.87	22 3 29.05
13 9 39 17.5	2	"	— 2 54.79	— 7 29.25	21 59 47.37	22 5 29.02
11 28 12.0	1	"	— 2 57.29	— 7 40.65	21 59 44.87	22 5 40.42
14 8 0 22.2	4	"	— 3 37.57	— 9 16.64	21 59 4.58	22 7 16.48
8 41 44.1	3	"	— 3 38.95	— 9 17.74	21 59 3.20	22 7 17.58
15 9 40 57.9	2	43106, Lal.	— 1 13.22	+ 10 10.21	21 58 15.53	22 9 6.31
10 38 3.6	2	"	— 1 15.00	+ 10 13.11	21 58 13.75	22 9 3.41
10 40 42.9	1	7724, B. A. C.	— 4 26.40	— 11 4.88	21 58 15.75	22 9 4.79
16 9 47 52.0	3	43106, Lal.	— 1 56.12	+ 8 50.66	21 57 32.64	22 10 26.00
18 9 20 17.0	5	"	— 3 19.03	+ 6 34.18	21 56 9.71	22 12 42.90
21 8 9 27.7	2	"	— 5 7.39	+ 4 48.42	21 54 21.32	22 14 29.09
(1) 25 8 19 44.1	1	42984, Lal.	— 3 29.30	+ 16 13.39	21 52 17.42	22 13 58.33
9 43 58.3	1	"	— 3 31.50	+ 16 17.03	21 52 15.22	22 13 54.69
27 8 59 57.7	2	"	— 4 22.55	. . . . .	. . . . .	. . . . .
(2) 9 21 37.6	1	"	— 8 5.10	+ 7 2.28	21 51 23.59	22 12 15.94
(1) 28 9 23 38.3	1	*f*	— 4 3.00	. . . . .	21 51 0.88	. . . .
Oct. 8 7 1 23.7	2	7649, B. A. C.	— 1 26.95	+ 3 0.71	21 48 53.56	21 50 44.60
9 1 20.3	1	"	— 1 28.50	+ 3 30.09	21 48 52.01	— 21 50 15.21

(1) Observations interrupted. (2) Cloudy.

1849. M. T. Washington.	No. of Comparisons.	Star of Comparison.	Planet — Star. Δα	Δδ	Planet's apparent α	δ
d h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
Oct. 11 8 28 9.3	3	7649, B. A. C.	— 1 30.57	+ 12 51.61	21 48 49.90	— 21 40 50.79
8 37 16.6	2	42700, Lal.	+ 1 31.80	+ 9 56.61	21 48 48.79	21 40 49.23
13 8 20 51.6	4	7649, B. A. C.	— 1 22.80	+ 20 14.91	21 48 57.64	21 33 32.56
8 13 49.5	5	42700, Lal.	+ 1 42.40	+ 17 14.72	21 48 56.55	21 33 31.60
14 8 2 22.9	4	*o*	+ 0 50.70	— 1 19.85	21 49 2.00	21 29 45.85
. . . .	4	*p*	— 0 52.05	— 2 48.01	21 49 2.54	21 29 43.54
15 8 27 6.9	4	*o*	+ 1 0.47	+ 2 52.37	21 49 11.83	21 25 33.54
. . . .	4	*p*	— 0 43.10	+ 1 20.94	21 49 11.48	21 25 34.50
(1) 24 8 35 46.14	3	*s*	+ 0 49.35	+ 0 48.05	21 51 47.24	20 42 21.01
10 43 30.2	3	*s*	+ 0 50.93	+ 1 22.55	21 51 48.82	20 41 46.51
25 7 13 21.0	7	*s*	+ 1 13.83	+ 5 57.64	21 52 11.71	20 37 11.51
7 24 49.7	4	*u*	— 0 32.81	— 6 37.40	21 52 11.99	20 37 4.37
(2) 26 9 43 15.3	2	*s*	+ 1 42.62	+ 12 11.85	21 52 40.48	20 30 57.38
. . . .	2	*u*	— 0 2.50	— 0 32.18	21 52 42.28	20 30 59.18
27 7 18 15.0	2	42813, Lal.	+ 2 37.46	— 6 34.72	21 53 7.92	20 25 47.06
8 46 26.0	5	"	+ 2 39.67	— 6 11.37	21 53 10.13	20 25 23.71
. . . .	5	*u*	+ 0 25.64	+ 5 3.16	21 53 10.40	— 20 25 23.83

(1) Windy night. (2) Hazy.

The apparent places of Metis have been derived from the following mean places of the stars of comparison, which are given for 1850.0. The right ascensions of several of them have been determined with the meridian circle, and the declinations with the mural circle at this Observatory. The declination of *f* has been obtained from comparisons with Lal. 43106, and the right ascension and declination of *u*, from comparisons with Lal. 42813, made with the equatorial.

	α	No. of Observations.	Ann. Prec.	δ	Ann. Prec.	No. of Observations.	Authority.
	h. m. s.		s.	° ′ ″	″		
B. A. C. 7724	22 2 42.60	—	+ 3.335	— 21 58 0.60	+ 17.490	—	B. A. C.
Lal. 43106	21 59 29.20	1	3.346	22 19 17.87	17.346	2	Wash'n Obs.
Lal. 42984	21 55 47.33	1	3.356	22 30 13.38	17.181	2	" "
f	21 55 4.50	1	3.357	22 25 22.55	18.368	—	" "
B. A. C. 7649	21 50 21.21	—	3.359	21 53 44.90	16.930	—	B. A. C.
o	21 48 12.16	2	3.357	21 28 24.60	16.830	1	Wash'n Obs.
p	21 49 55.56	2	3.353	21 26 54.09	16.910	3	" "
s	21 50 58.90	1	3.340	20 43 6.91	16.960	1	" "
u	21 52 45.70	—	3.334	20 30 24.56	17.131	—	" "
Lal. 42813	21 50 31.40	—	+ 3.335	— 20 19 10.06	+ 16.984	—	Lalande.

OBSERVATIONS OF METIS, MADE AT THE HAMBURG OBSERVATORY.

By PROFESSOR CHARLES RÜMKER.

[Kindly communicated to the Astronomical Journal, by Lieutenant MAURY.]

1849. M. T. Hamburg.	α	δ	
h m. s.	° ′ ″	° ′ ″	
July 22 12 51 0.9	340 37 41.8	— 17 18 4.7	Equatorial.
25 13 24 56.1	340 19 57.0	17 35 20.7	
28 12 18 38.0	339 58 44.9	17 52 56.8	
30 12 40 15.2	339 42 13.7	18 5 15.5	
Aug. 1 11 26 24.8	339 25 4.4	18 17 16.3	
11 11 38 26.5	337 34 45.0	19 23 41.1	
13 12 59 15.5	. . . . .	— 19 37 17.9	

1849.	M. T. Hamburg.	α	δ	
	h. m. s.	° ′ ″	° ′ ″	
Aug. 13	14 4 46.1	337 7 29.7	— 19 37 28.7	Equatorial.
14	12 14 0.4	336 55 11.4	19 43 43.1	
14	12 54 29.7	336 54 52.5	19 43 49.6	Merid. Circle.
15	12 49 39.8	336 41 29.3	19 50 18.8	
16	12 44 49.4	336 27 50.1	19 56 45.0	
17	12 39 58.6	336 14 5.1	20 3 11.7	
18	12 35 7.1	336 0 10.1	20 9 28.1	
19	12 30 14.6	335 45 57.7	20 15 41.8	
20	12 25 22.4	335 31 44.8	20 21 52.8	
25	12 0 52.9	334 19 9.0	20 51 4.5	
30	11 36 21.5	333 6 0.0	21 16 45.2	
Sept. 4	11 11 58.7	331 54 59.4	21 38 20.7	
5	11 7 7.8	331 41 12.4	21 42 8.4	
7	10 57 28.6	331 14 16.4	21 49 7.0	
9	10 47 52.5	330 48 8.0	21 55 15.1	
13	10 28 44.7	329 56 57.5	22 4 5.6	
15	10 19 32.3	329 36 45.0	22 8 46.3	
19	10 1 3.9	328 55 26.1	22 13 23.1	
20	9 56 30.7	328 46 6.7	22 14 5.9	
21	9 51 39.4	328 37 12.6	22 14 27.0	
23	9 43 1.5	328 20 38.7	22 14 35.6	
24	9 38 35.2	328 13 1.8	22 14 34.7	
25	9 34 10.7	328 5 51.5	22 14 7.2	
26	9 29 47.5	327 59 1.4	22 13 23.0	
27	9 25 26.4	327 52 43.1	22 12 43.7	
Oct. 1	9 8 20.3	327 32 1.3	— 22 7 25.6	

ON THE PHENOMENA ATTENDING THE DISAPPEARANCE OF THE RINGS OF SATURN.

By G. P. BOND,

ASSISTANT AT THE CAMBRIDGE OBSERVATORY.

In the course of each revolution of the planet Saturn, occupying a period of about thirty years, the plane of its ring twice intersects the sun ; so that alternately, for fourteen or fifteen years in succession, the north and south surfaces are illuminated by the solar rays, while the opposite side is immersed in darkness and winter of equal duration. The passage of the sun through the plane of the ring, the spring-time and autumn of the system, occurs in quarters of the heavens not far from our own vernal and autumnal equinoxes. At the times of these changes, the edge of the ring alone, for a short interval, receives the full light of the sun ; and at near these times the earth, by reason of its annual motion, passes once or twice through the plane before the comparatively slow motion of Saturn carries the line of the nodes across our orbit. At either of these phases, or whenever the earth and sun are on opposite sides of the ring, it becomes completely invisible, except with the most powerful telescopes ; owing to the feebleness of the light reflected from the extremely narrow illuminated edge then presented to the eye. For some months before and after these disappearances, while the earth and sun are elevated only at a very small angle above the ring, opportunities are afforded of observing some peculiarities relating to their disposition and structure, under the most favorable advantages of position.

These opportunities, it is much to be regretted, have never yet been fully improved. Either from the small number of instruments which have yet been constructed fitted for researches of so delicate a nature, or from a want of system and concert among observers, many interesting questions remain unsettled ; — such, too, as are clearly not beyond the reach of investigation with a proper use of such means of information as we can command.

The recent disappearance of the rings of Saturn in 1848 – 49 was made a subject of particular attention at the Cambridge Observatory during most of the interval which elapsed between

June, 1848, when the planet reached a favorable situation, and the final reappearance in January, 1849. Without going into any detail of these observations, it is proposed to refer to their results in connection with a brief statement of some of the questions and conjectures which have arisen relating to certain phenomena noticed at these periods.

By comparing the phases deduced from Bessel's elements of the ring with those recently observed, the correctness of the elements receives a strong confirmation, the discrepancies scarcely exceeding the limits of errors of observation. This is all the more conclusive from the epoch being one of unusual occurrence. The first reappearance of the ring in September, 1848, lasted only nine days. A similar instance has not taken place since 1656, or too early for valuable determinations. That this would be the case was pointed out by Dusejour as long ago as the middle of the last century.

The first disappearance in April, 1848, took place too soon after the conjunction of Saturn to be seen. The time of reappearance, caused by the passage of the plane of the ring through the sun, according to the phases given in the Nautical Almanac, which are derived from Bessel's elements, was about noon of the 3d of September, 1848, while the planet was below the horizon at Cambridge. The illumination of the southern surface was first noticed at two o'clock of the morning of the 4th.

The second disappearance happened at some time between two o'clock in the morning and ten in the evening of the 13th of September; the calculated time preceded the former limit by four or five hours. The final reappearance occurred at about six o'clock in the morning of the 19th of January, 1849, or between the same hour in the evenings of the 18th and 19th, and the calculated time is included within the same limits.

These agreements are quite remarkable, when we consider the very delicate nature of the phenomena under discussion. In neither of the above instances can we infer an error of three hundredths of a second of arc in the calculated minor axis of the ring.

At the distance of the earth from Saturn, the edge of the ring subtends an angle much too small to be subjected to any of the ordinary direct methods of measurement. We can, however, form an estimate of its thickness, which cannot very widely differ from the truth. This is done by comparing the amount of light reflected from the edge with that reflected from the surface of the ring, seen under a very small angle of elevation, assuming that the sides and edges of the ring have equal reflective power.

The illuminated area of the south side of the ring presented to the earth between the 4th and the 13th of September, never exceeded in breadth one quarter of a second of arc; yet, even when reduced to less than a tenth of a second, it was an object almost too bright for comparison with the slender filament of light which marked the edge of the ring. It would seem, therefore, that we can hardly assign a larger value than one hundredth of a second to the angle then subtended by the edge of the ring; giving a thickness of about forty miles. Compared with the diameter, this bears the proportion which the thickness of a common sheet of writing-paper does to its breadth.

It has been suggested that some inconsistencies noticed in the times of disappearance and reappearance of opposite sides of the ring might be attributed to a considerable mutual inclination of the planes of the north and south surfaces. With the thickness above assigned to the ring, an inclination of the two surfaces so great as one minute of arc is not possible; and even a much smaller value would seem at variance with the laws by which we conceive the stability of the ring to be maintained. But discrepancies have been referred to this source, amounting in one instance to nearly a quarter of a degree. Another argument against such a supposition is, that, if it were true that any great irregularity of the kind existed, it would be apparent, as the ring revolved about the planet, in an alternate increase and diminution of its brightness, in periods corresponding to that of the rotation of the ring. For since both surfaces could not at the same time coincide with the plane of rotation, when this was near the sun or the earth, one or the other of the surfaces would be successively presented to and turned from these bodies, and consequently be visible and invisible at regular intervals; this, if it takes place, has entirely escaped notice.

On similar grounds, we may question the existence of any bending or twist in the ring, large enough to be sensible. This would cause the east and west *ansæ* to be alternately brighter and fainter in like periods.

The appearance of inequalities on the ring, when the eye is near its plane, has been a subject of remark with almost all observers who have followed the planet through these phases with telescopes of superior power. Many of these, it is true, are to be referred to some one or other of the satellites, which are continually threading the ring as they cross and recross the disk of the planet. But there is still a general agreement as to the fact that the view of the ring, at near its disappearance, does not give the impression of an even and uniformly illuminated surface.

The first proposed way of accounting for these appearances is the one which naturally suggests itself, namely, that they arise from actual inequalities and protuberances of masses of matter sufficiently large to cast heavy shadows upon the planes about them, and when seen in relief, to break up the continuity of the edge, so as to make their presence sensible to our vision.

This view of the matter at one time seemed to be well established by the observations of Sir William Herschel, who determined, or at least supposed he had determined, by means of their prominences, a time of rotation of the exterior ring, which is that now usually received. From theoretical considerations alone, Laplace inferred the necessity of these inequalities for sustaining the equilibrium of the ring, and showed that the time of rotation must be nearly that given by Herschel. This agreement has long been regarded as an admirable mutual confirmation of observation and theory.

The careful and laborious investigations of SCHROETER at Lilienthal have, however, brought to our knowledge a state of things which at first sight tends greatly to weaken confidence in the above results, obtained by the great English astronomer, and, unless we can substitute some other for the most obvious explanation of them, must be held to throw a doubt upon the rotation of the ring altogether.

The observations in question were made at the Observatory at Lilienthal, in 1789 – 90 and 1802 – 3, with instruments of the first class, and prosecuted with a zeal and industry which lay a claim at once upon our confidence in what was seen by SCHROETER and his coadjutors, however we may differ from the conclusions he has drawn from the appearances described. There were points of light upon the edge of the ring, resembling in brilliancy small satellites, but with this extraordinary peculiarity, that during the whole period of observation they retained a position always unaltered with reference to the globe of the planet. It is on this feature of absolute fixedness and immobility that he insists, and, I think, no one can duly weigh the evidence which he brings forward in all its details, without admitting that the fact is indisputable. At the very commencement of our observations at Cambridge, the same condition was noticed, and was kept up throughout the series, establishing beyond the shadow of a doubt, that these irregularities, by whatever cause produced, are stationary, and have no movement of rotation about the globe of Saturn.

The impression conveyed to the mind on seeing these inequalities is, that they are masses of matter belonging to the structure of the ring, and adhering to it, so as of necessity to participate in all its motions. This, up to the present time, has been the opinion of all who have themselves witnessed the phenomenon. Convinced that they were motionless, SCHROETER boldly announced that this property proved with mathematical certainty, that the ring does not rotate, but always preserves one fixed, immovable position over Saturn's equator.

To meet this difficulty, different explanations have been proposed by LAPLACE and by Dr. OLBERS. The former considers the appearance of inequalities to be due to a small mutual inclination, and a slight difference in the nodes of the two rings. The latter, that it is a merely optical effect, which he shows to be produced in certain positions of the plane with reference to the line of vision. As this can only take place on the illuminated side, it fails in accounting for their being seen when the earth is above the unilluminated surface. Neither does LAPLACE's solution cover the difficulty, that the irregularities are strongly exhibited when the eye is directed towards the unilluminated surface, as is established incontestably by the Cambridge observations.

In this connection, we must not allow to pass unnoticed, that the authority of HERSCHEL asserting the motion of these points is brought forward by LAPLACE, as confirming his theory of the rotation of the ring, while that of SCHROETER, diametrically opposed to HERSCHEL's testimony, is used to confirm the theory of the nodes and inclinations. However, the small differences to which he alludes, as possibly existing in the nodes and inclinations of the rings, as well as, time of rotation, may, nevertheless, have place without interfering with the following explanation.

In treating of the theory of rings, the same great master has assumed that they are portions of extremely flattened ellipsoids. In this case, their outer edge would be brought to an extremely narrow apex, while the inner would be comparatively broad, and may be supposed to be perpendicular to the plane of the ring. The light reflected from these interior edges will exceed that from the outer, and will be abruptly cut off at different distances from the ball on each side, at the time of the disappearance of the ring. First, by the unilluminated surface of the inner ring, at a distance from the centre of Saturn equal to the interior radius of the inner ring. Again, by the unilluminated surface of the outer ring, at the distance of the inner radius of the outer ring; and between the two, and very close to the latter, will be visible the illuminated outer edge of the inner ring. Finally, on both sides of the ball will extend, uninterruptedly, the outer edge of the outer ring. Similar phenomena will also attend the reappearance.

Here, then, we have a succession of breaks and interruptions in the light of the ring when seen from near its plane, sufficient to give the impression of considerable inequalities. These result, not from any hypothesis framed purposely to account for the phenomena before us, but must exist, whatever we may suppose to be the figure of the ring, and must, too, become visible, when we can direct upon them a telescope of sufficient power. The condition of primary importance, that of retaining a fixed position, is satisfied without interfering with the rotation of the ring. The inequalities thus produced will also have place on both the bright and the dark sides, shining with a light intrinsically brighter than the rest of the surface, because receiving the rays of the sun perpendicularly.

We may thus satisfy some, at least, of the singular phenomena attending the disappearance of Saturn's ring, so as to reconcile many of the anomalous appearances which have hitherto perplexed astronomers, without requiring any other suppositions than those afforded by established facts, at the same time not precluding the possibility of other remaining sources of further irregularity.

ON THE HELIOCENTRIC PLACE OF NEPTUNE.

By GEORGE W. COAKLAY,

PROFESSOR OF MATHEMATICS IN THE COLLEGE OF ST. JAMES, MD.

Referring the elements of Neptune, as determined by Mr. S. C. Walker, to the meridian of Washington, Mean noon, January 1st, 1850, we have, —

$$\left.\begin{array}{lll} \text{Longitude of Epoch} & = E = & 11^{s}\ 5^{\circ}\ 9'\ 3''.25 \\ \text{“ \quad “ \quad Ascending Node} & = \theta = & 4\ 10\ 6\ 51.58 \\ \text{“ \quad “ \quad Perihelion} & = \varpi = & 1\ 17\ 14\ 37.27 \end{array}\right\} \text{M. Equinox, 1850.}$$

$$\begin{array}{lll} \text{Inclination} & = \varphi = & 1^{\circ}\ 46'\ 58''.97 \\ \text{Eccentricity} & = e = & 0.00871946 \\ \text{Mean daily motion} & = n = & 21''.55448. \end{array}$$

From these data we obtain, —

Mean distance $= a$; log. $a = 1.4776461$.

Let $v =$ the longitude on the undisturbed orbit at any time, t, from the epoch, and $R =$ the corresponding undisturbed radius-vector. Then we have, —

$$\left.\begin{array}{l} v = n\,t + E + A \sin.\ (n\,t + E - \varpi) \\ \qquad + B \sin.\ 2\,(n\,t + E - \varpi) \\ \qquad + C \sin.\ 3\,(n\,t + E - \varpi) \\ \qquad + \&c. \end{array}\right\} \quad (1)$$

in which, A, B, &c., are known functions of the eccentricity.

From the value of e in Mr. Walker's elements, I have found for these coefficients the following values: —

$$\left.\begin{array}{l} A_1 = 3597''.0840 \\ B_1 = \quad 19.6030 \\ C_1 = \quad 0.1482 \\ D_1 = \quad 0.0013 \end{array}\right\} \qquad \left.\begin{array}{l} \log.\ A_1 = 3.5559505 \\ \log.\ B_1 = 1.2923225 \\ \log.\ C_1 = \bar{1}.1708482 \end{array}\right\}$$

It is evident we may neglect D_1.

We have also, —

$$\left.\begin{array}{l} \log.\left(\dfrac{R}{a}\right) = 0.0000082551 - A_2 \cos.\ (n\,t + E - \varpi) \\ \qquad\qquad - B_2 \cos.\ 2\,(n\,t + E - \varpi) \\ \qquad\qquad - C_2 \cos.\ 3\,(n\,t + E - \varpi) \end{array}\right\} \quad (2)$$

In which

$$\log.\ A_2 = \bar{3}.5782724$$
$$\log.\ B_2 = \bar{5}.3938383$$
$$\log.\ C_2 = \bar{7}.3095237$$

With the preceding values of the constants, it is my intention to tabulate equations (1) and (2), and to supply such other tables in the usual form as are requisite to determine the place of Neptune at any time, with as great a degree of accuracy as the present state of its theory will allow. By this means I think that its theory will be more rapidly developed towards completeness. Having already made much progress in the construction of these tables, I send you so much of them as will serve to determine the heliocentric position of Neptune at any time during the year 1850.

TABLE I.

Washington Mean Noon.	Mean Longitude.	Long. of Perihelion	Long. of Ascending Node.
Jan. 1st, 1850.	$11^{s}\ 5^{\circ}\ 9'\ 3''.25$	$1^{s}\ 17^{\circ}\ 14'\ 37''.27$	$4^{s}\ 10^{\circ}\ 6'\ 51''.58$

TABLE II.

Mean Motion for Months.

January	$0^{\circ}\ 0'\ 0''.00$	July	$1^{\circ}\ 5'\ 1''.36$
February	0 11 8.19	August	1 16 9.55
March	0 21 11.71	September	1 27 17.74
April	0 32 19.90	October	1 38 4.37
May	0 43 6.54	November	1 49 12.56
June	0 54 14.73	December	1 59 59.20

TABLE III.

Mean Motion for Days.

1	$0'\ 21''.55$	9	$3'\ 13''.99$	17	$6'\ 6''.43$	25	$8'\ 58''.86$
2	0 43.11	10	3 35.55	18	6 27.98	26	9 20.42
3	1 4.66	11	3 57.10	19	6 49.54	27	9 41.97
4	1 26.22	12	4 18.65	20	7 11.09	28	10 3.53
5	1 47.77	13	4 40.21	21	7 32.64	29	10 25.08
6	2 9.33	14	5 1.76	22	7 54.20	30	10 46.63
7	2 30.88	15	5 23.32	23	8 15.75	31	11 8.19
8	2 52.44	16	5 44.87	24	8 37.31		

TABLE IV.

Hours.	Motion for Hours.	Hours.	Motion for Hours.	Hours.	Motion for Hours.	Hours.	Motion for Hours.
1	$0''.90$	7	$6''.29$	13	$11''.68$	19	$17''.06$
2	1.80	8	7.19	14	12.57	20	17.96
3	2.69	9	8.08	15	13.47	21	18.86
4	3.59	10	8.98	16	14.37	22	19.76
5	4.49	11	9.88	17	15.27	23	20.66
6	5.39	12	10.78	18	16.17	24	21.55

TABLE V.

Motion for Minutes.

Min.	Mean Mot.	Min.	Mean Mot.	Min.	Mean Mot.	Min.	Mean Mot.	Min.	Mean Mot.
1	$0''.015$	13	$0''.195$	25	$0''.375$	37	$0''.555$	49	$0''.735$
2	0.030	14	0.210	26	0.390	38	0.570	50	0.750
3	0.045	15	0.225	27	0.405	39	0.585	51	0.765
4	0.060	16	0.240	28	0.420	40	0.600	52	0.780
5	0.075	17	0.255	29	0.435	41	0.615	53	0.795
6	0.090	18	0.270	30	0.450	42	0.630	54	0.810
7	0.105	19	0.285	31	0.465	43	0.645	55	0.825
8	0.120	20	0.300	32	0.480	44	0.660	56	0.840
9	0.135	21	0.315	33	0.495	45	0.675	57	0.855
10	0.150	22	0.330	34	0.510	46	0.690	58	0.870
11	0.165	23	0.345	35	0.525	47	0.705	59	0.885
12	0.180	24	0.360	36	0.540	48	0.720	60	0.900

TABLE VI.

Motion for Seconds.									
Sec.	Mean Mot.	Sec.	Mean Mot	Sec.	Mean Mot.	Sec	Mean Mot.	Sec.	Mean Mot.
4	0″.001	16	0″.004	28	0″.007	40	0″.010	52	0″.013
8	0.002	20	0.005	32	0.008	44	0.011	56	0.014
12	0.003	24	0.006	36	0.009	48	0.012	60	0.015

TABLE VII.

Equation of the Centre, and Logarithm of the Radius-Vector.
Argument, (Mean Longitude — Longitude Perihelion,) or Mean Anomaly.

	Deg.	Equation.	Diff.		Deg.	Log. Rad.-Vector	Diff.
Sign IX. Subtract the Equation.	15	58′ 4″.21		Sign IX.	15	1.4766962	
	16	57 48.03	16″.18		16	1.4766320	0.0000642
	17	57 30.78	17.25		17	1.4765682	0.0000638
	18	57 12.47	18.31		18	1.4765047	0.0000635
	19	56 53.10	19.37		19	1.4764415	0.0000632
	20	56 32.68	20.42		20	1.4763786	0.0000629
	21	56 11.23	21.45				
	22	55 48.72	22.51				
	23	55 25.18	23.54				
	24	55 0.63	24.55				
	25	54 35.04	25.59				

TABLE VIII.

Perturb. in Orbit Long., and in Log. of Radius-Vector.

1850.	Perturb. in Long	Perturbation in Log. Radius-Vector.
January 1st	—0″.64	+0.00018411
April 1st	—3.83	+0.00018412
July 1st	—6.96	+0.00018501
October 1st	—9.96	+0.00018676

This table is derived from the Perturbations in Longitude and Radius-Vector, published by Professor Peirce.

TABLE IX.

Reduction to the Ecliptic both in Longitude and in Log. Radius-Vector
Argument (Longitude on the Orbit — Longitude of Ascending Node).

	Deg for all.	Reduct. in Long.	Diff.	Reduct. in Log. Radius-Vector	Diff.	Heliocentric Latitude.	Diff.
Sign VI. for the whole table	24	—37″.113		—0.000034779		—0° 43′ 30″.48	
	25	—38.256	1″.143	—0.000037548	2769	—0 45 12.41	101″.93
	26	—39 353	1.097	—0.000040400	2852	—0 46 53.53	101.12
	27	—40.402	1.049	—0.000043330	2930	—0 48 33.78	100.25
	28	—41 402	1.000	—0.000046335	3005	—0 50 13.14	99.36
	29	—42.351	0.949	—0.000049413	3078	—0 51 51.59	98.45
	30	—43.249	0.898	—0.000052557	3144	—0 53 29.10	97.51

NOTE OF PROFESSOR PEIRCE TO THE EDITOR.

Harvard University, Cambridge, January 2, 1850.

The following form of demonstrating the parallelogram of forces seems to me less objectionable in the mode of introducing infinitesimals than others which have hitherto been published. You will perceive that I have adopted Laplace's method of obtaining the magnitude of the resultant.

Let R be a force, which makes an angle θ with the axis of x, and of which the two components, in the directions of the rectangular axes x and y, are P and Q. It is plain that, if R is doubled, tripled, &c., P and Q will, each of them, be doubled, tripled, &c., and that if R is increased or diminished in any ratio, P and Q will be increased or diminished in the same ratio; or, in other words, that the mutual ratios of R, P, and Q will not be changed, unless the angle θ is also changed. If, then, each of the forces P and Q is resolved into two components, one of which is in the direction of R, and the other perpendicular to R, each of these components must bear the same ratio to its resultant which the component P or Q bears to its resultant, R. Hence, each of the two components perpendicular to R is equal to $\frac{PQ}{R}$, and they act in opposite directions, whereas the two components which lie in the direction of R are $\frac{P^2}{R}$ and $\frac{Q^2}{R}$, giving the equation

$$\frac{P^2 + Q^2}{R}, = R, \text{ or } P^2 + Q^2 = R^2.$$

Let now φ be determined by the condition that

$$P = R \cos. \varphi;$$

and the preceding equation gives

$$Q = R \sin. \varphi.$$

Let the angle φ' correspond in the same way to the angle θ', and let the angle θ be increased by θ', so that the angle which the resultant makes with the axis of x shall be $\theta + \theta'$. Let R be resolved into two components, of which the first makes an angle θ with the axis of x, and an angle θ' with R, while the other component is perpendicular to the first, and makes an angle θ with the axis of y. The values of these components must be respectively

$$R \cos. \varphi', \text{ and } R \sin. \varphi'.$$

Let each of these components be resolved into two, which act in the direction of the given axes. The components will be

$$R \cos. \varphi \cos. \varphi', \text{ and } — R \sin. \varphi \sin. \varphi',$$

in the direction of the axis of x, and

$$R \cos. \varphi \sin. \varphi', \text{ and } R \sin. \varphi \cos. \varphi',$$

in the direction of the axis of y, of which the sums are respectively

$$R \cos. (\varphi + \varphi'), \text{ and } R \sin. (\varphi + \varphi'),$$

so that the angle φ is increased by φ' when θ is increased by θ'. Were θ increased by any number of times θ', φ would be increased by the same number of times φ'; that is, if θ were to increase uniformly, φ would increase uniformly. But φ and θ vanish together, and are simultaneously equal to a right angle. If φ, therefore, increases uniformly from 0 to 90°, θ may have the same uniform rate of increase, and must consequently be always equal to φ; or the resultant of two rectangular components coincides in direction as well as magnitude with the diagonal of the parallelogram of which they are the sides.

BENJAMIN PEIRCE.

ON THE ORBIT OF THE GREAT COMET OF 1843.

BY PROFESSOR J. S. HUBBARD.

(*Continued from page* 13.)

§ 3.

The first steps in the following investigation will be recounted merely to illustrate by an example the difficulty of the computation, and the effect of small errors in the observations, or their reduction, upon the results.

From the list of orbits contained in the new edition of Olbers's "*Abhandlung*, &c.," Nicolai's parabola was taken, almost at random, and compared with the first observations of the above series as far as March 19, inclusive, with those of March 26, 27, and 28, and of April 5, 6, and 7. The residuals, furnished by the Trevandrum observations, being large and irregular, were projected upon a chart, a curve was drawn through and among the points thus laid down, and the required correction of ephemeris taken from the curve. For the other dates, the arithmetical mean of the discrepancies for each three days was taken, rejecting the Cracow observation on the 26th of March, and the right ascension observed at the same place on the 28th. The following normals were thus obtained: —

M. T. Berlin.		α	δ	Red. to M. Equinox, 1843.0	
Mar. 14d.	.10517	32° 39′ 23″.2	−11° 0′ 0″.4	$\Delta\alpha = -10''.21$	$\Delta\delta = +0''.01$
27	.32601	56 6 22.7	7 21 28.9	7.84	1.98
Apr. 6	.32593	66 21 57.1	− 5 16 11.9	− 6.21	+2.86

The reductions to mean right ascension here given are incorrect, owing to an error in transcribing from the wrong line of the computation; an error which was not detected until the work was already far advanced, and which was then considered of the less importance as the resulting elements were only intended as a closer approximation, and by no means as final.

With the above data, and computing by the Gaussian method, the following elliptic elements were obtained.

Elements I.

		M. T. Berlin M. Eq. 1843.0.
Per. Passage	$= T.$	= Feb. 27d.40462
Long. of Asc. Node	$= \pi$	= 359° 41′ 58″.66
Per. from Node	$= \omega$	= 81 9 57 .45
Inclination	$= i$	= 144 2 45 .09
Log. semi-axis major	$= l.\ a$	= 1.2125879
" Eccentricity	$= l.\ e$	= 9.9998467
" Per. dist.	$= l.\ q$	= 7.7603449.

Another ephemeris was now compnted, and compared with the normals as follows, the α and δ being still referred to the mean equinox of the beginning of the year.

	Computed α.	Error.	Computed δ.	Error.	Error of Appar. α	Reduction.
Mar. 14	32° 39′ 23″.3	+ 0″.1	−11° 0′ 1″.0	− 0″.6	− 0″.5	− 0″.6
27	56 6 22.3	− 0.4	7 21 28.2	+ 0.7	+ 4.6	+ 5.0
Apr. 6	66 21 56.9	− 0.2	− 5 16 11.4	+ 0.5	+ 7.3	+ 7.5

For the first Portland observation we have the computed distance = 4° 12′ 1″, the error of theory being therefore +346″. Extending the comparison through the dates of March and April, it was found that the representation of observations, though better than before, was still far from satisfactory, and the following errors were computed, assuming them, for convenience of calculation, as obtaining at mean noon Berlin.

	$\Delta\alpha$	$\Delta\delta$
Mar. 9.0	−13″.8	−45″.2
27.0	+ 3.6	+ 4.6
Apr. 12.0	+41.1	+70.8

(*To be continued.*)

Corrigenda in No. 2.

Page 9, line — 1, *for* 630° *read* 360°.
" 10, " 8, *for* "apparent" *read* "heliocentric."
" 11, " 23, *after* "parallax" *insert* "and aberration."
" 11, " —21, *for* 35° 3′ 13″.8 *read* 35° 5′ 27″.3.

Page 11, line — 14, *for* 41° 37′ 13″.0 *read* 41° 57′ 13″.0.
" 12, " — 28, " .30271 " .30071.
" 12, " — 20, " .35114 " .35110.
" 12, " — 2, " 6° 52′ 30″.2 " 6° 53′ 30″.2.

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ASTRONOMICAL JOURNAL.

No. 4.

VOL. I. CAMBRIDGE, FEBRUARY 2, 1850. NO. 4.

ON THE ORBIT OF THE GREAT COMET OF 1843.

By PROFESSOR J. S. HUBBARD.

(*Continued from page 24.*)

For these dates, and with Elements I., the coefficients of the variations of the elements with respect to the variation of the geocentric right ascension and declination were now computed, and, to insure accuracy, by two different methods. The first was that of Bessel, as given in his Treatises on the Comet of 1807 and Olbers's Comet. As these works are not common in this country, and as the formulas are not to be found collected elsewhere, I will here quote them for the benefit of other computers, and for convenience of future reference.

Denoting by $D_T v$, $D_e v$, $D_q v$, the differential coefficients of v with reference to T, e, and q, and similarly in the other formulas, and putting A', B', C', for $(A + \omega + v)$, $(B + \omega + v)$, $(C + \omega + v)$, we have

$$D_T v = -\frac{1}{r^2} \cdot \frac{h k}{\sin. 1''}. \qquad D_e v = -[V + 2\,V'(1-e)]^* = V_1. \qquad D_q v = -\frac{t}{r^2} \cdot \frac{3 h k}{2 q \sin. 1''}.$$

$$D_T r = -\sin. v \cdot \frac{e k}{h \sin. 1''}. \qquad D_e r = r^2 (1 - \cos. v) \cdot \frac{1}{h^2 (1+e) \sin. 1''} + V_1 \sin. v \cdot \frac{e}{h^2}. \qquad D_q r = -t \sin. v \frac{3 e k}{2 q h \sin. 1''} + r \cdot \frac{1}{q \sin. 1''}.$$

$$D_T x = x \cot. A' \cdot D_T v + \frac{x}{r} \cdot D_T r. \qquad D_T y = y \cot. B' \cdot D_T v + \frac{y}{r} \cdot D_T r. \qquad D_T z = z \cot. C' \cdot D_T v + \frac{z}{r} \cdot D_T r.$$

$$D_e x = x \cot. A' \cdot D_e v + \frac{x}{r} \cdot D_e r. \qquad D_e y = y \cot. B' \cdot D_e v + \frac{y}{r} \cdot D_e r. \qquad D_e z = z \cot. C' \cdot D_e v + \frac{z}{r} \cdot D_e r.$$

$$D_q x = x \cot. A' \cdot D_q v + \frac{x}{r} \cdot D_q r. \qquad D_q y = y \cot. B' \cdot D_q v + \frac{y}{r} \cdot D_q r. \qquad D_q z = z \cot. C' \cdot D_q v + \frac{z}{r} \cdot D_q r.$$

$$D_\omega x = x \cot. A'. \qquad D_\omega y = y \cot. B'. \qquad D_\omega z = z \cot. C'.$$

$$D_n x = -y \cos. \varepsilon - z \sin. \varepsilon. \qquad D_n y = x \cos. \varepsilon. \qquad D_n z = x \sin. \varepsilon.$$

$$D_i x = r \sin. u \cos. a. \qquad D_i y = r \sin. u \cos. b. \qquad D_i z = r \sin. u \cos. c.$$

$$D_x \alpha = -\sin. \alpha \sec. \delta \cdot \tfrac{1}{\Delta}. \qquad D_y \alpha = \cos. \alpha \sec. \delta \cdot \tfrac{1}{\Delta}.$$

$$D_x \delta = -\cos. \alpha \sin. \delta \cdot \tfrac{1}{\Delta} \qquad D_y \delta = -\sin. \alpha \sin. \delta \cdot \tfrac{1}{\Delta} \qquad D_z \delta = \cos. \delta \cdot \tfrac{1}{\Delta}.$$

$$= \cot. \alpha \sin. \delta \cos. \delta \cdot D_x \alpha. \qquad = -\tan. \alpha \sin. \delta \cos. \delta \cdot D_y \alpha.$$

* The coefficients V and V' are given by Bessel, in the *Monatl. Corr.*, XII. p. 197.

The coefficients were also computed by the method of GÖTZE, as given in the *Astronomische Nachrichten*, Nos. 655 and 656. This method, in the case before us, gives equal or even greater accuracy, with less labor of computation than the former. Besides the coefficients themselves, the logarithms of their sums were also obtained, to serve as a control in the subsequent operations.* Weights were assigned to the equations, proportional to the square root of the number of observations employed in each, and the form

$$0 = n + a\,p + b\,q + c\,r + d\,s + e\,t + f\,u$$

given to them, where

$$\begin{aligned} 0^{d}.0002\ p &= \Delta T \\ 1''\ q &= \Delta n \\ 2''\ r &= \Delta \omega \\ 1''\ s &= \Delta i \\ .000001\ t &= \Delta q \\ .000001\ u &= \Delta e. \end{aligned}$$

The following are the logarithms of n, of the coefficients, and of their sums: —

	Log. n	Log. a	Log. b	Log. c	Log. d	Log. e	Log. f	Log. S
March 9	1.47971 *n*	0.56883 *n*	9.00205 *n*	9.03372	9.39650	9.77547 *n*	0.34570	0.26204 *n*
9	2.00463 *n*	9.85524	9.59825 *n*	9.51957	0.06200	9.76101 *n*	9.77535 *n*	9.80029
27	1.40642	0.61405 *n*	0.44382	0.85509 *n*	9.81542	1.00160	1.28571	1.33246
27	1.49414	9.82074	0.03760 *n*	9.57167	0.70709	9.72479 *n*	0.41021 *n*	0.28701
April 12	1.76309	9.55800 *n*	9.86292	0.26318 *n*	8.86894	0.35845	0.61801	0.70253
12	2.00054	9.01358	9.21460 *n*	8.61184 *n*	0.02510	8.37596	9.86444 *n*	9.39751

The final equations, the resulting values of our unknown quantities, and of Elements II. are

$$\begin{aligned}
0 &= -\ 5.44334 + 0.01420\,u \\
0 &= -\ 20.37574 + 0.13534\,u + 0.12707\,t \\
0 &= 37.30849 - 0.30667\,u + 0.03818\,t + 0.07830\,s \\
0 &= -\ 90.45191 - 9.87367\,u - 7.52945\,t - 11.65892\,s + 5.35880\,r \\
0 &= 84.23793 + 24.10224\,u + 14.60889\,t - 4.08048\,s - 10.03923\,r + 4.83705\,q \\
0 &= -\ 55.38970 - 91.30682\,u - 40.64900\,t + 0.66911\,s + 30.19540\,r - 12.33934\,q + 31.7307\,p
\end{aligned}$$

		Elements II.
$p = 266.226$	$\Delta T = +\ 0^{d}.053245$	T Feb. $27^{d}.457855$
$q = 5742.10$	$\Delta n = +\ 5742''.10$	n $1^{\circ}\ 20'\ 34''.72$
$r = 2868.75$	$\Delta \omega = +\ 5737.50$	ω 82 45 30.12
$s = 1146.26$	$\Delta i = +\ 1146.26$	i 144 21 50.14
$t = -\ 248.038$	$\Delta q = -\ .00024804$	q 0.00551096
$u = 383.442$	$\Delta e = +\ .00038344$	e assumed = 1

These elements give, for the first Portland observation, the distance equal to 4° 04′ 31″, the error being now —104″. A complete representation of our data cannot, with such large corrections of the elements, be expected, but only a closer approximation. And we now select the following from comparisons already made with Elements I., to form new normals: —

	$\Delta\alpha$	$\Delta\delta$		$\Delta\alpha$	$\Delta\delta$
Mar. 8	—18″.6	+26″.9	Mar. 18	+19″.9	—23″.1
9	+ 9.1	—45.8	"	— 6.9	—30.0
10	+15.4	—90.4	"	+12.1	—47.5
11	—51.1	—38.3	"	— 7.0	—17.3
"	—24.0	—78.5	"	+13.6	(+45.3)

	$\Delta\alpha$	$\Delta\delta$		$\Delta\alpha$	$\Delta\delta$
Mar. 27	+12″.9	— 1″.3	Apr. 2	+23″.1	— 7″.4
"	— 7.0	+ 9.3	"	—20.2	+ 2.1
"	—30.1		"	— 7.8	+20.7
"	+ 3.1	— 8.3	3	+51.8	(+103.5)
"	+ 7.0	+38.8	5	+18.2	+28.7
			"	— 3.1	+ 2.9

	$\Delta\alpha$	$\Delta\delta$
April 9	+34″.7	+94″.6
10	(—41.0)	
15	+47.5	+47.0

* ENCKE, *Zeitschrift für Astronomie*, VI. p. 151.

The mean of each group of these quantities, applied with the contrary sign to the ephemeris based upon Elements I., gave the following normals, referred to the mean equinox of 1843.0: —

	α	No. Obs.	δ	No. Obs.	Errors of Elements II.	
March 9.0	18° 7′ 52″.3	5	— 12° 1′ 25″.5	5	$\Delta\alpha = -$ 4″.9	$\Delta\delta = +$ 44″.6
18.0	41 20 5.0	5	9 53 45.5	4	+ 13.5	+ 50.6
27.0	55 41 31.8	4	7 26 24.4	4	— 10.7	+ 59.2
April 4.0	64 18 35.3	6	5 41 45.1	5	— 20.9	+ 20.4
12.0	70 45 23.7	2	— 4 23 27.7	2	— 8.5	+ 44.5

The coefficients of new equations of condition were computed by the same methods as before, and adopting as the signification of the unknown quantities,

$$[6.52288] \,.\, \mathrm{p} = \Delta T$$
$$[4.30103] \,.\, \mathrm{q} = \Delta q$$
$$[3.69897] \,.\, \mathrm{r} = \Delta e$$
$$[0.52288] \,.\, \mathrm{s} = \Delta \omega$$
$$[0.52288] \,.\, \mathrm{t} = \Delta n$$
$$[0.30103] \,.\, \mathrm{u} = \Delta i$$

The logarithms of n ($\Delta\alpha$ cos. δ and $\Delta\delta$), of the coefficients and their sums are

Log. n	Log. a	Log. b	Log. c	Log. d	Log. e	Log. f	Log. S
0.68057 *n*	0.44239 *n*	9.80656 *n*	9.71936	8.85145	9.12854 *n*	9.35033	0.43542 *n*
1.64933	9.72394	9.76346 *n*	9.15445 *n*	9.44672	9.76493 *n*	0.01529	9.73270
1.12382	0.21476 *n*	0.19826	0.05692	0.00298 *n*	9.87294	9.38524	0.02578
1.70415	9.37404	9.65571 *n*	9.26918 *n*	9.41967	9.80014 *n*	0.14873	9.80498
1.02571 *n*	9.98345 *n*	0.41079	0.15676	0.22451 *n*	0.11660	9.30150	0.45916
1.77232	9.20611	9.28662 *n*	9.32266 *n*	9.14239	9.72209 *n*	0.17958	9.94478
1.31800 *n*	9.79837 *n*	0.46069	0.18636	0.29897 *n*	0.19753	9.20469	0.54919
1.30963	9.13356	8.66564 *n*	9.39273 *n*	8.73115	9.64544 *n*	0.18286	9.99037
0.92815 *n*	9.63152 *n*	0.47566	0.19358	0.33557 *n*	0.23760	9.10079	0.58118
1.64836	9.08178	8.54940	9.46546 *n*	6.90161 *n*	9.57996 *n*	0.17919	9.99734

The above equations were now solved twice; first after receiving weights proportioned to the square root of the number of observations upon which each normal was based, with the exception of the last two, to which the weight of unity was given; and secondly, allowing equal weights to all the equations. The results of the two solutions are: —

A.

For the controlling quantities we have

	(S n)	(S a)	(S b . 1)	(S c . 2)	(S d . 3)	(S e . 4)	(S f . 5)
	141.6910	6.35174	118.93330	0.23239	— 0.70323	— 6.63958	.00414
By addition	141.6909	6.35173	118.93332	0.23239	— 0.70322	— 6.63958	.00409

And for the final equations, using logarithms, —

$$0 = [9.90140] + [7.61194]\,\mathrm{u}$$
$$0 = -[2.48182] - [0.96959]\,\mathrm{u} + [0.42880]\,\mathrm{t}$$
$$0 = -[0.82286] - [0.01100]\,\mathrm{u} + [8.97223]\,\mathrm{t} + [9.35912]\,\mathrm{s}$$
$$0 = [1.21265] - [9.58341]\,\mathrm{u} + [9.34085]\,\mathrm{t} - [9.48489]\,\mathrm{s} + [9.84617]\,\mathrm{r}$$
$$0 = -[2.70013] - [9.86280]\,\mathrm{u} + [1.66954]\,\mathrm{t} - [1.75463]\,\mathrm{s} + [1.60666]\,\mathrm{r} + [1.95109]\,\mathrm{q}$$
$$0 = [2.48222] - [9.40742]\,\mathrm{u} - [1.27417]\,\mathrm{t} + [1.36693]\,\mathrm{s} - [1.46953]\,\mathrm{r} - [1.45143]\,\mathrm{q} + [1.77733]\,\mathrm{p}$$

Whence

				Elements III.
Log. p	1.69044 *n*	$\Delta T = -$ 0^{d}.016343	T	Feb. 27^{d}.441512
Log. q	0.91883	$\Delta q = +$ .00001659	n	0° 49′ 16″.41
Log. r	2.34346 *n*	$\Delta e = -$ .00011026	ω	82 11 25 .56
Log. s	2.78772 *n*	$\Delta\omega = -$ 2044″.56	i	144 15 20 .65
Log. t	2.75089 *n*	$\Delta n = -$ 1878 .31	q	0.00552755
Log. u	2.28946 *n*	$\Delta i = -$ 389 .49	e	0.99988974

B.

	(S n)	(S a)	(S b . l)	(S c . 2)	(S d . 3)	(S e . 4)	(S f . 5)
Controlling Quantities	63.38000	.010437	31.68453	— .132166	— .228727	— 1.617857	.001110
By addition	63.38001	.010436	31.68453	— .132170	— .228728	— 1.617859	.001092

Final Equations.

$$0 = -[8.18772] + [7.03830]\,u$$
$$0 = -[1.87703] - [0.35651]\,u + [9.81604]\,t$$
$$0 = -[0.79672] - [9.52459]\,u + [8.47570]\,t + [8.88093]\,s$$
$$0 = -[0.77873] - [9.60293]\,u + [9.13747]\,t - [8.88440]\,s + [9.31813]\,r$$
$$0 = -[2.03170] + [9.11415]\,u + [1.09970]\,t - [1.18833]\,s + [1.03406]\,r + [1.37267]\,q$$
$$0 = +[1.85512] + [9.17159]\,u - [0.65217]\,t + [0.73930]\,s - [0.81676]\,r - [0.83482]\,q + [1.08844]\,p$$

		Results.		Elements IV.
Log. p	0.71399 n	$\Delta T = -0^{\mathrm{d}}.001725$	T	Feb. $27^{\mathrm{d}}.456130$
Log. q	1.30694 n	$\Delta q = -.00004055$	n	$1^\circ\ 29'\ 41''.53$
Log. r	1.35622 n	$\Delta e = -.00001135$	ω	82 49 56 .61
Log. s	1.90280	$\Delta \omega = +266''.49$	i	144 22 18 .35
Log. t	2.21496	$\Delta n = +546\ .81$	q	0.00547041
Log. u	1.14942	$\Delta i = +\ 28\ .21$	e	0.99998864

With corrections so large as in the first solution, the original equations would not be satisfied by substitution of the results in place of the unknown quantities themselves. We have, however, performing the substitution, —

	By Equations A.				By direct Computation.	
	$\Delta\alpha\cos\delta\sqrt{p}$.	$\Delta\delta\sqrt{p}$.	$\Delta\alpha\cos\delta$.	$\Delta\delta$.	$\Delta\alpha\cos\delta$.	$\Delta\delta$.
March 9	$-\ 2''.99$	$-\ 0''.09$	$-\ 1''.34$	$-\ 0''.04$	$-\ 1''.5$	$+\ 4''.7$
18	+ 11.43	— 7.20	+ 5.11	— 3.60	+ 6.3	+ 7.8
27	— 11.84	+ 27.25	— 5.92	+ 13.62	— 5.0	+ 19.4
April 4	— 7.38	— 28.68	— 3.01	— 12.83	— 1.7	— 7.3
12	+ 22.79	+ 23.28	+ 22.79	+ 23.28	+ 19.2	+ 28.5

	By Equations B.		By direct Computation.	
	$\Delta\alpha\cos\delta$.	$\Delta\delta$.	$\Delta\alpha\cos\delta$.	$\Delta\delta$.
March 9	$-\ 2''.64$	$-\ 1''.64$	$-\ 2''.7$	$-\ 1''.4$
18	+ 9.26	+ 0.12		
27	— 7.10	+ 12.98	— 7.5	+ 13.3
April 4	— 9.36	— 20.46		
12	+ 9.82	+ 10.12	+ 9.4	+ 9.0

The sums of the squares of the residuals are, —

Elements III. (Direct Computation) = 1763″.30
" IV. (Equations) = 1024 .39

Correcting the two Portland observations for refraction, and neglecting the effect of parallax, which must be inappreciable, we have for the observed and computed distances, —

Observed.	Elements III.	Elements IV.	Errors III.	Errors IV.
$4^\circ\ 6'\ 19''$	$4^\circ\ 7'\ 37''$	$4^\circ\ 5'\ 33''$	$+\ 78''$	$-\ 46''$
4 7 34	4 8 18	4 6 14	+ 44	— 80

These errors include between them the diameter of the nucleus. Although Captain Clark appeared better satisfied with the first of the two observations, we shall consider them, for the present at least, as equally good, and assume the mean of the two errors as giving the correct amount of deviation of theory. We thus have, —

By Elements III. Error = + 61″.
" " IV. = — 63 .

§ 4.

We come now to the reduction of the Chihuahua observations. This could not be performed without at least an approximate knowledge of the comet's position, since Mr. Bowring, in giving his observation for time, has omitted to state which limb of the sun was observed, and we can only decide the question by trial.

By "erreur du sextant," we presume Mr. Bowring intends index-correction,* and by "une marche assez régulière de —$1^{\mathrm{m}}\ 15^{\mathrm{s}}$ par jour," we understand that his chronometer was

* We beg leave here to protest against the too frequent misuse of the word "error" in astronomical communications. The distinction of sign between an error and its correction should not be overlooked.

losing 75^s daily. Computing the time from the observed altitude of the sun, we find that if the upper limb were observed, the correction of the chronometer would be $+37^m\ 19^s.67$; if the lower, $+34^m\ 19^s.43$. Applying the necessary reduction for rate, we obtain for the local mean time of observation of the comet's altitudes, and for the altitudes themselves, by Elements IV., —

Upper Limb.		Lower Limb.		Observation.
h. m. s.	° ′ ″	h. m. s.	° ′ ″	° ′ ″
1 40 9.65	49 58 14	1 37 9.40	50 17 12	50 30 7
2 39 46.25	41 51 8	2 36 46.01	42 19 52	42 20 6

The observed altitudes have been corrected for index-error, refraction, and parallax. Something is evidently wrong in the first observation, and a slight examination shows, that, if we assume the given time as $1^h\ 0^m\ 53^s.5$ instead of $1^h\ 2^m\ 53^s.5$, the computed altitude becomes 50° 29′ 29″. The second hypothesis, that the lower limb of the sun was observed, is thus confirmed. Elements III. were now also subjected to the test of these observations; the two orbits give, —

	Computed Altitudes.		Errors.	
	° ′ ″	° ′ ″	″	″
III.	50 29 59	42 20 55	— 8	+ 49
IV.	50 29 29	42 19 52	— 38	— 14

The effect of an assumed error in the given latitude of the place of observation was next considered, and it was found that an error of 1′ in the latitude would produce a change of only 9″ in the altitude of the comet; we may presume the actual error to be less than this. The uncertainty in the longitude is of still less importance.

With regard to the observed distance from the sun given by Mr. Bowring, we can derive no satisfactory result. Elements IV. give the following computed distances: —

Chron. Time.	Nearest Limb.	Farthest Limb.
h. m.	° ′ ″	° ′ ″
1 32.5	3 48 32	4 20 50
2 32.5	3 58 35	4 30 53
3 32.5	4 8 28	4 40 46
4 32.5	4 18 16	4 50 34
5 32.5	4 28 0	5 0 18

Whence we infer, that at $4^h\ 12^m$ Chron. time, the distances were respectively 4° 15′ 0″ and 4° 47′ 18″. The nearest limb was 3° 54′ distant from the comet at $2^h\ 5^m$; the farthest limb was 4° 54′ distant at $4^h\ 53^m$ Chron. time. We can make no satisfactory hypothesis of typographical or other error which will sufficiently reconcile theory and observation, and shall therefore be compelled to confine ourselves to the altitudes alone.

Thus far we are scarcely able to decide between the two sets of elements last obtained. Judging from the tests of February 28, too little weight was assigned to our last normal in solution A, and too great weight in solution B. As Elements IV. seem on the whole to give the best representation of observations, we will proceed with these in our approximations, and before instituting the final comparison with the whole series of observations, will take into account the effect of perturbations.

(To be continued.)

OBSERVATIONS OF METIS,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

(Communicated by Lieutenant Maury, Superintendent of the Observatory.)

[Corrected for refraction.]

	1849. M. T. Washington.	No. of Comparisons.	Star of Comparison.	Metis — Star. $\Delta\alpha$	Metis — Star. $\Delta\delta$	Observed α	Observed δ
	d. h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
	Nov. 2 6 55 57.8	3	x	— 0 2.06	— 0 48.93	21 56 34.14	— 19 48 52.72
	8 21 43.2	10	x	+ 0 1.37	— 0 18.55	56 37.57	48 22.34
	8 54 58.2	3	43040, Lal.	— 0 53.80	—24 30.37	56 38.73	48 13.52
	. . . .	3	x	+ 0 2.46	—24 10.91	56 38.66	48 14.70
(1)	3 8 23 12.7	4	43040, Lal.	— 0 16.09	—18 2.73	57 16.43	41 45.88
	4 7 3 52.5	13	"	+ 0 22.70	—11 41.61	57 55.21	35 25.58
	5 8 27 40.5	7	"	+ 1 7.42	— 4 25.94	58 39.92	28 10.33
	6 7 31 51.9	5	"	+ 1 49.43	+ 2 15.37	59 21.92	21 29.48
	. . . .	5	7711, B. A. C.	— 1 22.55	— 6 22.79	21 59 21.49	— 19 21 29.32

(1) Cloudy.

	1849. M. T. Washington.	No. of Comparisons.	Star of Comparison.	Metis — Star. $\Delta\alpha$	Metis — Star. $\Delta\delta$	Observed α	Observed δ
	d. h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
(1)	Nov. 7 7 48 17.1	10	7711, B. A. C.	— 0 36.92	+ 0 49.33	22 0 7.14	— 19 14 17.26
(2)	10 7 11 56.4	5	"	+ 1 44.76	+22 26.43	2 28.79	18 52 40.34
(3)	12 7 19 17.8	3	a′	+ 0 7.71	+14 27.71	4 11.54	37 16.56
	9 23 53.9	6	43288, Lal.	— 0 5.08	+ 9 4.59	4 14.21	36 38.23
(3)	13 7 37 56.5	6	"	+ 0 44.51	+16 13.94	5 3.74	18 29 28.88
	26 8 8 5.4	1	h′	— 0 4.80	+ 0 23.11	. . . .	. . . .
	27 7 35 40.3	5	i′	— 1 8.80	+ 5 50.48	. . . .	. . . .
(4)	Dec. 5 7 2 10.9	5	7836, B. A. C.	+ 6 41.20	+ 4 31.03	28 57.63	15 16 36.25
	. . . .	5	k′	+ 6 3.50	+ 3 27.22	28 57.48	16 36.24
(2)	6 6 57 21.25	16	644, W. C.	— 0 20.02	—16 5.08	30 12.97	6 52.96
	6 33 45.46	4	640, W. C.	— 0 17.90	—16 49.41	30 10.69	15 7 3.99
(2)	11 6 44 27.2	8	7954, B. A. C.	— 4 55.61	+ 6 11.06	36 41.94	14 16 51.75
	6 57 2.7	3	815, W. C.	— 1 32.50	+ 2 10.14	36 41.06	16 45.21
	12 6 30 0.0	6	7954, B. A. C.	— 3 36.47	+16 21.80	38 1.06	14 6 41.07
	18 5 51 59.5	6	7976, B. A. C.	+ 0 2.34	— 4 43.58	46 10.19	13 4 12.85
	6 15 7.6	4	"	+ 0 4.42	— 4 31.52	46 12.27	13 4 0.79
(5)	24 7 2 6.7	6	1149, 1150 } W. C.	+ 0 24.62	+ 9 13.78	54 55.27	11 57 50.48
	. . . .	6	1156, W. C.	+ 0 15.29	+ 6 29.33	54 55.19	57 52.12
(6)	27 6 15 42.7	8	1232, W. C.	+ 1 15.77	— 9 43.80	22 59 18.20	11 24 37.77
	31 6 32 18.2	7	85, W. C.	— 0 18.64	+ 6 8.81	23 5 20.87	10 38 49.24
(4)(5)	1850. Jan. 5 6 11 50.5	3	8109, B. A. C.	+ 3 0.56	+20 16.64	23 10 5.95	— 9 39 39.14

(1) Cloudy. (2) High wind. (3) Fine. (4) Misty. (5) Planet scarcely visible. (6) Planet 11 mag.

Mean Places of the Stars of Comparison for 1850.0.

	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
43040, Lal.	8	21 57 33.52	— 19 23 41.72	Equatorial differentiated from 7711, B. A. C.
x	9	21 56 37.19	19 48 2.30	" " " "
7711, B. A. C.	5½	22 0 45.07	19 15 3.40	
a′	9	22 4 4.87	18 51 41.90	" " " "
43288, Lal.	9½	22 4 21.27	18 45 40.45	differentiated from a′.
h′	8.9	22 17 52.00	16 39 52.00	from instrument readings.
i′	9	22 20 37.00	16 25 10.30	
7836, B. A. C.	6	22 22 14.68	15 21 2.60	
k′		22 22 55.18	15 19 58.78	differentiated from 7836, B. A. C.
640, W. C.	9	22 30 29.73	14 50 12.13	
644, W. C.	8	22 30 34.22	14 50 45.43	
7954, B. A. C.	5½	22 41 38.75	14 22 57.20	
815, W. C.	9	22 38 14.80	14 18 49.70	
7976, B. A. C.	7	22 46 12.52	12 59 2.80	
1149, 1150 } W. C.	9	22 54 31.91	12 6 58.15	
1156, W. C.	8	22 54 41.16	12 4 15.35	
1232, W. C.	8	22 58 3.64	11 14 47.70	
85, W. C.	9	23 5 40.72	10 44 51.48	
8109, B. A. C.	5	23 10 6.54	— 10 0 4.20	

DEVELOPMENT OF THE PERTURBATIVE FUNCTION OF PLANETARY MOTION.

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(*Supplement to the article in No.* 1.)

Terms of the Sixth Degree in Reference to the Inclinations and Eccentricities.

The following tables contain the coefficients of $b_{\frac{1}{2}}^{(i)}$, $\alpha\, b_{\frac{3}{2}}^{(i)}$, &c., ... $\alpha\, D_\alpha b_{\frac{1}{2}}^{(i)}$, $\alpha^2\, D_\alpha b_{\frac{3}{2}}^{(i)}$, ... $\alpha^2\, D_\alpha^2 b_{\frac{1}{2}}^{(i)}$, $\alpha^3\, D_\alpha^2 b_{\frac{3}{2}}^{(i)}$, &c., in the expressions of K_6, L_6, M_6, &c., $\varDelta\, K_6$, $\varDelta'\, K_6$, $\varDelta\, L_6$, &c. By adopting the notation given in No. 1 of the *Astronomical Journal*, and also putting

$$K_s^{(i)} = h_s^{(i)} - b_s^{(i)}$$

$$l_s^{(i)} = b_s^{(i+3)} + 18\, b_s^{(i)} + b_s^{(i-3)}$$

the terms of $a'\, R$, which involve six dimensions of the eccentricities and inclinations, are

$$\Big[\tfrac{1}{4608} e^6 N_6 + \tfrac{1}{4608} e'^6 \Sigma^3 . \Sigma' . N_6 + \tfrac{1}{512} e^2 e'^4 \Sigma^2 . O_6 + \tfrac{1}{512} e^4 e'^2 O_6 - \tfrac{1}{256} e^4 \lambda^2 V_6 - \tfrac{1}{256} e'^4 \lambda^2 \Sigma^2 . \Sigma' . V_6 - \tfrac{1}{64} e^2 e'^2 \lambda^2 \Sigma' V_6$$

$$+ \tfrac{3}{64} (e^2 + e'^2) \lambda^4 \mathbf{B}_6 - \tfrac{5}{32} \lambda^6 l_{\frac{7}{2}}\Big]^{(i)} \cos.\, i\, l_0$$

$$+ \Big[- \tfrac{1}{768} e\, e'^5 \Sigma^2 . \Sigma' . N_6 - \tfrac{1}{768} e^5 e' \Sigma . N_6^{(-1)} - \tfrac{1}{256} e^3 e'^3 \Sigma . \Sigma' . O_6 + \tfrac{1}{64} e\, e'^3 \lambda^2 (\Sigma . \Sigma' . + \varDelta''.) V_6 + \tfrac{1}{64} e^3 e' \lambda^2 (\Sigma + \varDelta''.) V_6$$

$$- \tfrac{3}{32} e\, e' \lambda^4 \Sigma . \mathbf{B}_6\Big]^{(i+1)} \cos.\, (i\, l_0 + \varpi - \varpi')$$

$$+ \Big[\tfrac{1}{768} e^2 e'^4 \Sigma . \Sigma' . N_6 + \tfrac{1}{768} e'^2 e^4 \Sigma^2 . N_6^{(-1)} - \tfrac{1}{128} e^2 e'^2 \lambda^2 (\Sigma^2 . + 2\varDelta'' + \varDelta\varDelta'') V_6\Big]^{(i+2)} \cos.\, (i\, l_0 + 2\varpi - 2\varpi')$$

$$- \tfrac{1}{2304} e^3 e'^3 \Sigma' . N_6^{(i+3)} \cos.\, (i\, l_0 + 3\varpi - 3\varpi')$$

$$+ \left(\tfrac{1}{192} e^4 \lambda^2 R_6 + \tfrac{1}{64} e^2 e'^2 \lambda^2 \Sigma . \Sigma' R_6 - \tfrac{3}{32} e^2 \lambda^4 \Sigma' . Y_6\right)^{-(i+1)} \cos.\, (i\, l_0 + 2\varpi - 2\theta_0)$$

$$- \left(\tfrac{1}{64} e\, e'^3 \lambda^2 \Sigma^2 . \Sigma' R_6 + \tfrac{1}{64} e' e^3 \lambda^2 \Sigma . R_6 - \tfrac{3}{16} e\, e' \lambda^4 \Sigma . \Sigma' Y_6\right)^{(-i)} \cos.\, (i\, l_0 + \varpi + \varpi' - 2\theta_0)$$

$$+ \left(\tfrac{1}{192} e'^4 \lambda^2 \Sigma^3 . \Sigma' . R_6 + \tfrac{1}{64} e^2 e'^2 \lambda^2 \Sigma^2 . R_6 - \tfrac{3}{32} e'^2 \lambda^4 \Sigma^2 . \Sigma' . Y_6\right)^{-(i-1)} \cos.\, (i\, l_0 + 2\varpi' - 2\theta_0)$$

$$- \tfrac{1}{192} e' e^3 \lambda^2 \Sigma' . R_6^{-(i+2)} \cos.\, (i\, l_0 + 3\varpi - \varpi' - 2\theta_0) - \tfrac{1}{192} e\, e'^3 \lambda^2 \Sigma^3 . R_6^{-(i-2)} \cos.\, (i\, l_0 + 3\varpi' - \varpi - 2\theta_0)$$

$$+ \Big[\tfrac{1}{3072} e^6 M_6 + \tfrac{1}{512} e^2 e'^4 \Sigma^2 . \Sigma'^2 . M_6 + \tfrac{1}{384} e'^2 e^4 \Sigma . \Sigma' . M_6 - \tfrac{1}{192} e^4 \lambda^2 U_6 - \tfrac{1}{64} e^2 e'^2 \lambda^2 \Sigma . \Sigma' . U_6$$

$$+ \tfrac{3}{64} e^2 \lambda^4 \mathbf{A}_6\Big]^{i} \cos.\, (i\, l_0 + 2\, l - 2\varpi)$$

$$- \Big[\tfrac{1}{768} e^5 e' \Sigma . M_6 + \tfrac{1}{256} e^3 e'^3 \Sigma^2 . \Sigma' . M_6 - \tfrac{1}{64} e\, e'^3 \lambda^2 \Sigma^2 . \Sigma' . U_6 - \tfrac{1}{64} e^3 e' \lambda^2 \Sigma . U_6$$

$$+ \tfrac{3}{32} e\, e' \lambda^4 \Sigma . \mathbf{A}_6\Big]^{(i+1)} \cos.\, (i\, l_0 + 2\, l - \varpi - \varpi')$$

$$+ \Big[\tfrac{1}{3072} e'^6 \Sigma^4 . \Sigma'^2 . M_6 + \tfrac{1}{384} e^2 e'^4 \Sigma^3 . \Sigma' . M_6 + \tfrac{1}{512} e^4 e'^2 \Sigma^2 . M_6 - \tfrac{1}{192} e'^4 \lambda^2 \Sigma^3 . \Sigma' . U_6 - \tfrac{1}{64} e^2 e'^2 \lambda^2 \Sigma^2 . U_6$$

$$+ \tfrac{3}{64} e'^2 \lambda^4 \Sigma^2 . \mathbf{A}_6\Big]^{(i+2)} \cos.\, (i\, l_0 + 2\, l - 2\varpi')$$

$$- \Big[\tfrac{1}{1536} e^5 e' \Sigma' . M_6 + \tfrac{1}{768} e^3 e'^3 \Sigma . \Sigma'^2 . M_6 - \tfrac{1}{192} e^3 e' \lambda^2 \Sigma' . U_6\Big]^{(i+1)} \cos.\, (i\, l_0 + 2\, l - 3\varpi + \varpi')$$

$$- \Big[\tfrac{1}{1536} e\, e'^5 \Sigma^4 . \Sigma' . M_6 + \tfrac{1}{768} e^3 e'^3 \Sigma^3 . M_6 - \tfrac{1}{192} e\, e'^3 \lambda^2 \Sigma^3 . U_6\Big]^{(i+3)} \cos.\, (i\, l_0 + 2\, l - 3\varpi' + \varpi)$$

$$+ \tfrac{1}{3072} e'^2 e^4 \Sigma'^2 . M_6^{(i-2)} \cos. (i l_0 + 2 l - 4 \varpi + 2 \varpi') + \tfrac{1}{3072} e^2 e'^4 \Sigma^4 . M_0^{(i+4)} \cos. (i l_0 + 2 l - 4 \varpi' + 2 \varpi)$$

$$+ \Big[\tfrac{1}{128} e^4 \lambda^2 S_6 + \tfrac{1}{128} e'^4 \lambda^2 \Sigma^2 . \Sigma'^2 . S_6 + \tfrac{1}{32} e^2 e'^2 \lambda^2 \Sigma . \Sigma' . S_6 - \tfrac{3}{16} e^2 \lambda^4 Z_6 - \tfrac{3}{16} e'^2 \lambda^4 \Sigma^2 . Z_6$$

$$+ \tfrac{15}{16} \lambda^6 k_{\frac{7}{2}}\Big]^{(i+6)} \cos. (i l_0 + 2 l - 2 \theta_0)$$

$$- \Big[\tfrac{1}{64} e e'^3 \lambda^2 \Sigma . \Sigma'^2 S_6 + \tfrac{1}{64} e' e^3 \lambda^2 \Sigma' . S_6 - \tfrac{3}{16} e e' \lambda^4 (\Sigma + \Delta') Z_6\Big]^{(i+2)} \cos. i l_0 + 2 l + \varpi - \varpi' - 2 \theta_0)$$

$$- \Big[\tfrac{1}{64} e e'^3 \lambda^2 \Sigma^2 . \Sigma' . S_6 + \tfrac{1}{64} e' e^3 \lambda^2 \Sigma . S_6 - \tfrac{3}{16} e e' \lambda^4 (\Sigma - \Delta') Z_6\Big]^{(i)} \cos. (i l_0 + 2 l + \varpi' - \varpi - 2 \theta_0)$$

$$+ \tfrac{1}{128} e^2 e'^2 \lambda^2 \Sigma'^2 . S_6^{(i+3)} \cos. (i l_0 + 2 l + 2 \varpi - 2 \varpi' - 2 \theta_0) + \tfrac{1}{128} e^2 e'^2 \lambda^2 \Sigma^2 . S_6^{(i-1)} \cos. (i l_0 + 2 l + 2 \varpi' - 2 \varpi - 2 \theta_0)$$

$$+ \tfrac{1}{768} e^4 \lambda^2 \Sigma' . P_6^{(i-1)} \cos. (i l_0 + 2 l - 4 \varpi + 2 \theta_0) - \tfrac{1}{192} e^3 e' \lambda^2 \Sigma . \Sigma' . P_6^{(i)} \cos. (i l_0 + 2 l - 3 \varpi - \varpi' + 2 \theta_0)$$

$$+ \tfrac{1}{128} e^2 e'^2 \lambda^2 \Sigma^2 . \Sigma' . P_6^{(i+1)} \cos. (i l_0 + 2 l - 2 \varpi - 2 \varpi' + 2 \theta_0) - \tfrac{1}{192} e e'^3 \lambda^2 \Sigma^3 . \Sigma' . P_6^{(i+2)} \cos. (i l_0 + 2 l - \varpi - 3 \varpi' + 2 \theta_0)$$

$$+ \tfrac{1}{768} e'^4 \lambda^2 \Sigma^4 . \Sigma' . P_6^{(i+3)} \cos. (i l_0 + 2 l - 4 \varpi' + 2 \theta_0) + \tfrac{3}{64} e^2 \lambda^4 \Sigma' . W_6^{-(i+2)} \cos. (i l_0 + 2 l + 2 \varpi - 4 \theta_0)$$

$$- \tfrac{3}{32} e e^2 \lambda^4 . \Sigma . \Sigma' . W_6^{-(i+1)} \cos. (i l_0 + 2 l + \varpi + \varpi' - 4 \theta_0) + \tfrac{3}{64} e'^2 \lambda^4 \Sigma^2 . \Sigma' . W_6^{(-i)} \cos. (i l_0 + 2 l + 2 \varpi' - 4 \theta_0)$$

$$+ \Big[\tfrac{1}{7680} e^6 L_6 + \tfrac{1}{1536} e'^2 e^4 \Sigma . \Sigma' . L_6 - \tfrac{1}{768} e^4 \lambda^2 T_6\Big]^{(i)} \cos. (i l_0 + 4 l - 4 \varpi)$$

$$- \Big[\tfrac{1}{1536} e^5 e' \Sigma . L_6 + \tfrac{1}{768} e^3 e'^3 \Sigma^2 . \Sigma' . L_6 - \tfrac{1}{192} e^3 e' \lambda^2 \Sigma . T_6\Big]^{(i+1)} \cos. (i l_0 + 4 l - 3 \varpi - \varpi')$$

$$+ \Big[\tfrac{1}{768} e^4 e'^2 \Sigma^2 . L_6 + \tfrac{1}{768} e^2 e'^4 \Sigma^3 . \Sigma' . L_6 - \tfrac{1}{128} e^2 e'^2 \lambda^2 \Sigma^2 . T_6\Big]^{(i+2)} \cos. (i l_0 + 4 l - 2 \varpi - 2 \varpi')$$

(To be continued.)

NOTICE.

Authors who may detect errors in their communications are earnestly requested to inform the editor at their earliest convenience. If notice of the errors arrive at too late a period for them to be corrected before publication, they will be mentioned as "Corrigenda" in the next number of the Journal. Should errors of the press be detected at any time, it will afford the editor pleasure to be enabled to correct them at as early a date as possible.

G.

Corrigenda in the "Observations of Metis," in No. 3.

Page 17, line 4, *for* 10h. 29m. 56s.3 *read* 11h. 29m. 46s.3.
" 17, " —4, the Star of Comparison should be 43106, Lal.
" 17, " " *for* 21h. 51m. 23s.59 *read* 21h. 51m. 24s.39.
" 18, in the Ann. Precession in Decl. of *f*, *for* 18″.368 *read* 17″.148.

Page 18, in Ann. Prec. in Decl. of *u*, *for* 17″.131 *read* 17″.043.
" 18, " " " Lal. 42813, " 16.984 " 16.938.

To the table of apparent places should be added the following: —

	α	No. Obs.	Ann. Prec.	δ	Ann. Prec.	No. Obs.	Authority.
Lal. 42700	21h. 74m. 14s.72	3	+3.361	−21° 50′ 44″.88	+16.783	4	Wash'n Obs

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THE
ASTRONOMICAL JOURNAL.
No. 5.

VOL. I. CAMBRIDGE, MARCH 12, 1850. NO. 5.

DEVELOPMENT OF THE PERTURBATIVE FUNCTION OF PLANETARY MOTION.

By BENJAMIN PEIRCE, LL. D.

PERKINS PROFESSOR OF ASTRONOMY AND MATHEMATICS IN HARVARD UNIVERSITY.

(*Continued from page 32.*)

$$-\left[\tfrac{1}{768}e^3e'^3\Sigma^3.L_6+\tfrac{1}{1536}ee'^5\Sigma^4.\Sigma'.L_6-\tfrac{1}{192}ee'^3\lambda^2\Sigma^3.T_6\right]^{(i+3)}\cos.(il_0+4l-\varpi-3\varpi')$$

$$+\left[\tfrac{1}{1536}e^2e'^4\Sigma^4.L_6+\tfrac{1}{7680}e'^6\Sigma^5.\Sigma'.L_6-\tfrac{1}{768}e'^4\lambda^2\Sigma^4.T_6\right]^{(i+4)}\cos.(il_0+4l-4\varpi')$$

$$-\tfrac{1}{7680}e^5e'\Sigma'.L_6^{(i-1)}\cos.(il_0+4l-5\varpi+\varpi')+\tfrac{1}{7680}ee'^5\Sigma^5.L_6^{(i+5)}\cos.(il_0+4l-5\varpi'+\varpi)$$

$$+\left[\tfrac{1}{192}e^4\lambda^2Q_6+\tfrac{1}{64}e^2e'^2\lambda^2\Sigma.\Sigma'.Q_6-\tfrac{3}{32}e^2\lambda^4Y_6\right]^{(i+1)}\cos.(il_0+4l-2\varpi-2\theta_0)$$

$$-\left[\tfrac{1}{64}e^3e'\lambda^2\Sigma.Q_6+\tfrac{1}{64}ee'^3\lambda^2\Sigma^2.\Sigma'.Q_6-\tfrac{3}{16}ee'\lambda^4\Sigma.Y_6\right]^{(i+2)}\cos.(il_0+4l-\varpi-\varpi'-2\theta_0)$$

$$+\left[\tfrac{1}{64}e^2e'^2\lambda^2\Sigma^2.Q_6+\tfrac{1}{192}e'^4\lambda^2\Sigma^3.\Sigma'.Q_6-\tfrac{3}{32}e'^2\lambda^4\Sigma^2.Y_6\right]^{(i+3)}\cos.(il_0+4l-2\varpi'-2\theta_0)$$

$$-\tfrac{1}{192}e^3e'\lambda^2\Sigma'.Q_6^{(i)}\cos.(il_0+4l-3\varpi+\varpi'-2\theta_0)-\tfrac{1}{192}ee'^3\lambda^2\Sigma^3.Q_5^{(i+4)}\cos.(il_0+4l-3\varpi'+\varpi-2\theta_0)$$

$$+\left[\tfrac{3}{32}e^2\lambda^4X_6+\tfrac{3}{32}e'^2\lambda^4\Sigma^2X_6-\tfrac{15}{16}\lambda^6g_{\frac{7}{2}}\right]^{(i+2)}\cos.(il_0+4l-4\theta_0)$$

$$-\tfrac{3}{32}ee'\lambda^4(\Sigma+\Delta')X_6^{(i+3)}\cos.(il_0+4l-\varpi'+\varpi-4\theta_0)-\tfrac{3}{32}ee'\lambda^4\Sigma(1-\Delta')X_6^{(i+1)}\cos.(il_0+4l-\varpi+\varpi'-4\theta_0)$$

$$+\tfrac{1}{46080}e^6K_6^{(i)}\cos.(il_0+6l-6\varpi)-\tfrac{1}{7680}e^5e'\Sigma K_6^{(i+1)}\cos.(il_0+6l-5\varpi-\varpi')$$

$$+\tfrac{1}{3072}e^4e'^2\Sigma^2.K_6^{(i+2)}\cos.(il_0+6l-4\varpi-2\varpi')-\tfrac{1}{2304}e^3e'^3\Sigma^3.K_6^{(i+3)}\cos.(il_0+6l-3\varpi-3\varpi')$$

$$+\tfrac{1}{3072}e^2e'^4\Sigma^4.K_6^{(i+4)}\cos.(il_0+6l-2\varpi-4\varpi')-\tfrac{1}{7680}ee'^5\Sigma^5.K_6^{(i+5)}\cos.(il_0+6l-\varpi-5\varpi')$$

$$+\tfrac{1}{46080}e'^6\Sigma^6.K_6^{(i+6)}\cos.(il_0+6l-6\varpi')+\tfrac{1}{768}e^4\lambda^2P_6^{(i+1)}\cos.(il_0+6l-4\varpi-2\theta_0)$$

$$-\tfrac{1}{192}e^3e'\lambda^2\Sigma.P_6^{(i+2)}\cos.(il_0+6l-3\varpi-\varpi'-2\theta_0)+\tfrac{1}{128}e^2e'^2\lambda^2\Sigma^2.P_6^{(i+3)}\cos.(il_0+6l-2\varpi-2\varpi'-2\theta_0)$$

$$-\tfrac{1}{192}ee'^3\lambda^2\Sigma^3.P_6^{(i+4)}\cos.(il_0+6l-\varpi-3\varpi'-2\theta_0)+\tfrac{1}{768}e'^4\lambda^2\Sigma^4.P_6^{(i+5)}\cos.(il_0+6l-4\varpi'-2\theta_0)$$

$$+\tfrac{3}{64}e^2\lambda^4W_6^{(i+2)}\cos.(il_0+6l-2\varpi-4\theta_0)-\tfrac{3}{32}ee'\lambda^4\Sigma.W_6^{(i+3)}\cos.(il_0+6l-\varpi-\varpi'-4\theta_0)$$

$$+\tfrac{3}{64}e'^2\lambda^4\Sigma^2.W_6^{(i+4)}\cos.(il_0+6l-2\varpi'-4\theta_0)+\tfrac{5}{16}\lambda^6b_{\frac{7}{2}}^{(i+3)}\cos.(il_0+6l-6\theta_0).$$

TABLE I.

$b_{\frac{1}{2}}$	i	αD_α	i^2	$i \alpha D_\alpha$	$\alpha^2 D^2_\alpha$	i^3	$i^2 \alpha D_\alpha$	$i \alpha^2 D^2_\alpha$	$\alpha^3 D^3_\alpha$	i^4	$i^3 \alpha D_\alpha$
K_6	+ 29352	— 7776	+ 48538	— 36324	+ 6180	+ 29835	— 37890	+ 15810	— 2160	+ 8660	— 15780
L_6	— 3608	+ 1536	— 8588	+ 5956	— 1280	— 8200	+ 7710	— 2510	+ 320	— 3740	+ 4640
M_6	+ 136	— 96	+ 314	— 380	+ 80	+ 593	— 516	+ 142	+ 16	+ 788	— 556
N_6	0	0	— 172	0	0	0	— 18	0	0	+ 196	0
O_6	0	0	0	0	0	0	— 34	0	+ 48	+ 36	0
ΔK_6	— 31546	+ 9026	— 47510	+ 38160	— 7355	— 24905	+ 34000	— 15290	+ 2260	— 5480	+ 10760
ΔL_6	+ 3866	— 1806	+ 8720	— 6348	+ 1469	+ 7518	— 7240	+ 2314	— 284	+ 2752	— 3488
$\Delta' L_6$	+ 1414	— 286	+ 840	— 1620	+ 405	— 310	— 1040	+ 1030	— 220	— 240	— 160
ΔM_6	— 146	+ 106	— 282	+ 396	— 87	— 643	+ 596	— 140	— 44	— 816	+ 536
$\Delta' M_6$	+ 122	— 174	+ 850	— 552	+ 109	+ 1317	— 824	+ 94	+ 20	+ 680	— 488
ΔN_6	— 10	+ 10	+ 164	+ 36	— 7	— 2	+ 140	— 14	— 28	— 328	+ 128
$\Delta' N_6$	+ 702	+ 702	— 2328	— 1824	— 225	+ 3258	+ 1716	+ 336	— 264	— 2184	— 672
ΔO_6	0	— 18	0	0	— 9	0	+ 164	0	+ 72	— 232	0
$\Delta' O_6$	+ 2	0	— 20	+ 16	0	+ 86	0	+ 200	0	0	— 224
$\Delta^2 K_6$	+ 31564	— 10916	+ 45760	— 40288	+ 8582	+ 18732	— 28104	+ 13932	— 2280	+ 2416	— 5232
$\Delta^2 L_6$	— 4212	+ 2236	— 8910	+ 6860	— 1746	— 6588	+ 6420	— 1794	+ 144	— 1544	+ 1952
$\Delta \Delta' L_3$	— 1672	+ 428	— 972	+ 1952	— 562	+ 168	+ 1056	— 1104	+ 264	+ 96	+ 128
$\Delta^2 M_6$	+ 156	— 116	+ 214	— 412	+ 94	+ 774	— 780	+ 138	+ 184	+ 872	— 376
$\Delta \Delta' M_6$	— 112	+ 196	— 882	+ 584	— 110	— 1179	+ 678	+ 12	— 48	— 396	+ 236
$\Delta'^2 M_6$	+ 444	— 196	+ 973	— 472	+ 54	+ 621	— 288	— 48	+ 24	+ 128	— 64
$\Delta^2 N_6$	— 68	+ 140	— 610	+ 464	— 74	— 900	+ 408	+ 72	— 48	— 600	+ 96
$\Delta \Delta' N_6$	— 612	— 744	+ 1962	+ 1518	+ 96	— 2448	— 1152	+ 102	+ 444	+ 1488	0
$\Delta^2 O_6$	0	+ 84	0	0	+ 330	0	— 472	0	+ 192	+ 496	0
$\Delta^3 K_6$	— 39108	+ 14148	— 42108	+ 42144	— 10386	— 10674	+ 18288	— 10386	+ 1956		
$\Delta^3 L_6$	+ 4700	— 3060	+ 9298	— 7588	+ 2186	+ 5060	— 4504	— 74	+ 556		
$\Delta^2 \Delta' L_6$	+ 2044	— 676	+ 1062	— 2388	+ 834	— 52	— 888	+ 1038	— 292		
$\Delta^3 M_6$	— 220	— 108	+ 290	+ 1220	— 26	— 1936	+ 424	+ 550	+ 20		
$\Delta^2 \Delta' M_6$	+ 100	— 236	+ 950	— 656	+ 102	+ 974	— 328	— 292	+ 84		
$\Delta \Delta'^2 M_6$	— 428	+ 196	— 780	+ 336	— 18	— 328	+ 96	+ 96	— 28		
$\Delta^3 N_6$	— 468	+ 252	— 990	+ 324	+ 18	— 552	+ 72	— 510	— 36		
$\Delta^2 \Delta' N_6$	+ 612	+ 756	— 1158	— 1548	+ 774	+ 2418	— 264	— 102	+ 132		
$\Delta^4 K_6$	+ 17160	— 21072	+ 34368	— 42144	+ 12792						
$\Delta^4 L_6$	— 5384	+ 6160	— 11048	+ 5952	+ 1032						
$\Delta^3 \Delta' L_6$	— 2664	+ 1232	— 1004	+ 2976	— 1432						
$\Delta^4 M_6$	— 888	— 848	+ 2624	— 480	— 392						
$\Delta^3 \Delta' M_6$	— 32	+ 560	— 1390	+ 120	+ 312						
$\Delta^2 \Delta'^2 M_6$	+ 416	— 208	+ 552	— 96	— 72						
$\Delta^3 \Delta' N_6$	0	— 720	+ 2052	0	— 360						
$\Delta^5 K_6$	— 68232	+ 46656									
$\Delta^5 L_6$	+ 12568	— 4096									
$\Delta^4 \Delta' L_6$	+ 4152	— 4096									
$\Delta^4 \Delta' M_6$	+ 648	+ 64									
$\Delta^3 \Delta'^2 M_6$	— 461	+ 64									

$$\Delta^6 K_6 = +46656\, b_{\frac{1}{2}}$$

$$\Delta^5 \Delta' L_6 = -1096\, b_{\frac{1}{2}}$$

$$\Delta^4 \Delta'^2 M_6 = +64\, b_{\frac{1}{2}}$$

Explanation of the Table. — Each number in these tables is the coefficient of the function which is placed at the top of the vertical column, in the development of the function which is written in the same horizontal line with the number and at the left of the table. Thus Table I. gives, —

$$\Delta \overset{i}{L_6} = (352\, i^5 + 2752\, i^4 + 7518\, i^3 + 8720\, i^2 + 3866\, i)\, b^{(i)}_{\frac{1}{2}}$$

$$- (576\, i^4 + 3488\, i^3 + 7240\, i^2 + 6348\, i + 1806)\, \alpha\, D_\alpha\, b^i_{\frac{1}{2}}$$

$$+ (240\, i^3 + 1218\, i^2 + 2314\, i + 1469)\, \alpha^2\, D^2_\alpha\, b^i_{\frac{1}{2}}$$

$$+ (64\, i^2 - 20\, i - 284)\, \alpha^3\, D^3_\alpha\, b^i_{\frac{1}{2}} - (66\, i + 38)\, \alpha^4\, D^4_\alpha\, b^i_{\frac{1}{2}} + 12\, \alpha^5\, D^5_\alpha\, b^i_{\frac{1}{2}}$$

It must be observed, however, that D_α is always written at the top of the table without annexing the function of which it denotes the differential coefficient, and this function is also omitted in the term of which it is simply a factor, but it is written once for all in the left-hand corner at the top of the table.

TABLE I. — (CONTINUED.)

$b_{\frac{1}{2}}$	$i^2\alpha^2D^2_\alpha$	$i\alpha^3D^3_\alpha$	$\alpha^4D^4_\alpha$	i^5	$i^4\alpha D_\alpha$	$i^3\alpha^2D^2_\alpha$	$i^2\alpha^3D^3_\alpha$	$i\alpha^4D^4_\alpha$	$\alpha^5D^5_\alpha$	i^6	$i^5\alpha D_\alpha$	$i^4\alpha^2D^2_\alpha$	$i^3\alpha^3D^3_\alpha$	$i^2\alpha^4D^4_\alpha$	$i\alpha^5D^5_\alpha$	$\alpha^6D^6_\alpha$
K_6	+10725	−3220	+360	+1200	−2880	+2760	−1320	+315	−30	+64	−192	+240	−160	+60	−12	+1
L_6	−1865	+240	0	−800	+1280	−640	+40	+50	−10	−64	+128	−80	0	+20	−8	+1
M_6	+53	+68	−24	+400	−320	−40	+88	−23	+2	+64	−64	−16	+32	−4	−4	+1
N_6	−33	0	0	0	0	0	−21	0	+6	−64	0	+48	0	−12	0	+1
O_6	−89	0	+52	0	+64	0	−72	0	+14	−64	0	+48	0	−12	0	+1
ΔK_6	−7890	+2560	−310	−432	+1120	−1160	+600	−155	+16							
ΔL_6	+1248	−20	−38	+352	−576	+240	+64	−66	+12							
$\Delta' L_6$	+540	−300	+50	−32	0	+80	−80	+30	−4							
ΔM_6	+36	−120	+38	−272	+192	+104	−80	−9	+8							
$\Delta' M_6$	−30	+80	−14	+112	−96	−24	+40	−9	0							
ΔN_6	+90	−76	+14	−192	+32	+112	−24	−16	+4							
$\Delta' N_6$	+738	+384	+42	+576	+96	−336	−72	+48	+12							
ΔO_6	+10	0	+38	0	+32	0	−24	0	+4							
$\Delta' O_6$	0	+128	0	+192	0	−112	0	+16	0							
$\Delta^2 K_6$	+4236	−1520	+204													
$\Delta^2 L_6$	−390	−308	+104													
$\Delta\Delta' L_6$	−360	+216	−60													
$\Delta^2 M_6$	−342	+88	+36													
$\Delta\Delta' M_6$	+117	−84	+8													
$\Delta'^2 M_6$	−48	+32	−4													
$\Delta^2 N_6$	+156	−52	0													
$\Delta\Delta' N_6$	−708	0	+72													
$\Delta^2 O_6$	−236	0	+24													

TABLE II.

$b_{\frac{3}{2}}$	α	$i\alpha$	α^2D_α	$i^2\alpha$	$i\alpha^2D_\alpha$	$\alpha^3D^2_\alpha$	$i^3\alpha$	$i^2\alpha^2D_\alpha$	$i\alpha^3D^2_\alpha$	$\alpha^4D^3_\alpha$	$i^4\alpha$	$i^3\alpha^2D_\alpha$	$i^2\alpha^3D^2_\alpha$	$i\alpha^4D^3_\alpha$	$\alpha^5D^4_\alpha$
P_6	+125	+528	−200	+475	−416	+90	+152	−216	+102	−16	+16	−32	+24	−8	+1
Q_6	−36	−204	+84	−244	+172	−33	−108	+96	−21	0	−16	+16	0	−4	+1
R_6	+4	−12	−4	+20	−20	+9	+20	0	−21	+8	−16	+16	0	−4	+1
S_6	−1	+30	−24	+79	−48	+4	+64	−24	−16	+8	+16	0	−8	0	+1
ΔP_6	−189	−732	+304	−525	+504	−120	−100	+156	−81	+14					
$\Delta' P_6$	−116	−588	+224	−528	+480	−108	−128	+192	−96	+16					
$\Delta\Delta' P_6$	+180	+796	−336	+552	−552	+138	+64	−96	+48	−8					
ΔQ_6	+60	+324	−148	+302	−208	+37	+80	−48	−16	+10					
$\Delta' Q_6$	+36	+172	−76	+126	−144	+39	+24	−48	+30	−6					
ΔR_6	−4	+12	+12	−34	+8	+13	+16	−16	0	+2					
$\Delta' R_3$	−12	+60	−28	+30	−24	+3	−40	+48	−18	+2					
ΔS_6	+1	+62	+16	−17	+32	−12	−4	+12	−1	+2					
$\Delta' S_6$	+1	−58	+64	−137	+40	+46	−60	−20	+17	+6					
$\Delta^2 P_6$	+334	+1116	−528	+506	−552	+150									
$\Delta^2\Delta' P_6$	−324	−1196	+592	−464	+196	−132									
$\Delta^2 Q_6$	−138	−618	+344	−308	+56	+66									
$\Delta\Delta' Q_6$	−66	−286	+144	−132	+176	−56									
$\Delta^2 R_6$	+2	+6	−8	−4	+8	−2									
$\Delta\Delta' R_6$	+10	−54	+32	+28	−32	+8									
$\Delta^2 S_6$	+2	−130	−16	+16	−24	+10									
$\Delta\Delta' S_6$	+3	−34	−56	+27	−24	−8									
$\Delta'^2 S_6$	+26	+254	+64	+160	+104	+14									
$\Delta^3 P_6$	−816	−1944	+1128												
$\Delta^3\Delta' P_6$	+828	+1940	−1120												
$\Delta^3 Q_6$	+1038	+854	+208												
$\Delta^2\Delta' Q_6$	+174	+550	−368												
$\Delta^3 R_6$	−6	+6	0												
$\Delta^2\Delta' R_6$	−6	+6	0												
$\Delta^2\Delta' S_6$	−10	+94	+56												
$\Delta\Delta'^2 S_6$	−106	−98	−8												

$$\Delta P_6 = 5016\,\alpha\, b_{\frac{3}{2}}$$
$$\Delta^3\Delta' P_6 = -5016\,\alpha\, b_{\frac{3}{2}}$$
$$\Delta^3\Delta' Q_6 = -1152\,\alpha\, b_{\frac{3}{2}}$$
$$\Delta^3\Delta' R_6 = 12\,\alpha\, b_{\frac{3}{2}}$$
$$\Delta^2\Delta'^2 S_6 = 188\,\alpha\, b_{\frac{3}{2}}$$

TABLE III.

$g_{\frac{3}{2}}$	α	$i\,\alpha$	$\alpha^2 D_\alpha$	$i^2 \alpha^2$	$i\,\alpha^2 D_\alpha$	$\alpha^3 D^2_\alpha$	$i^3\,\alpha$	$i^2 \alpha^2 D_\alpha$	$i\,\alpha^3 D^2_\alpha$	$\alpha^4 D^3_\alpha$	$i^4\,\alpha$	$i^3 \alpha^2 D_\alpha$	$i^2 \alpha^3 D^2_\alpha$	$i\,\alpha^4 D^3_\alpha$	$\alpha^5 D^4_\alpha$
T_6	— 64	— 30	+ 32	+ 115	— 80	+ 12	+ 88	— 120	+ 54	— 8	+ 16	— 32	+ 24	— 8	+ 1
U_6	+ 16	+ 24	— 8	— 16	+ 28	— 12	— 44	+ 18	— 21	+ 4	— 16	+ 16	0	— 4	+ 1
V_6	0	0	0	— 17	0	+ 12	0	— 21	0	+ 8	+ 16	0	— 8	0	+ 1
$\Delta\, T_6$	+ 82	+ 14	— 32	— 153	+ 132	— 27	— 68	+ 108	— 57	+ 10					
$\Delta\, U_6$	— 22	— 28	+ 8	+ 38	— 68	+ 33	+ 48	— 32	— 8	+ 6					
$\Delta'\, U_6$	+ 2	— 4	+ 8	— 18	+ 12	— 3	— 8	0	+ 6	— 2					
$\Delta\, V_6$	— 6	0	0	+ 19	0	+ 9	0	— 4	0	+ 2					
$\Delta'\, V_6$	+ 4	0	+ 32	+ 1	0	+ 26	0	— 8	0	+ 4					
$\Delta''\, V_6$	0	+ 16	0	0	+ 36	0	— 28	0	+ 9	0					
$\Delta^2\, T_6$	— 120	+ 38	+ 16	+ 210	— 240	+ 68									
$\Delta^2\, U_6$	+ 48	+ 6	+ 80	— 92	+ 32	+ 16									
$\Delta\,\Delta'\, U_6$	0	+ 10	— 16	+ 12	+ 8	— 8									
$\Delta^2\, V_6$	— 8	0	— 16	+ 24	0	— 4									
$\Delta\,\Delta'\, V_6$	+ 8	0	+ 16	— 13	0	+ 4									
$\Delta^2\,\Delta'\, V_6$	+ 24	0	+ 48	— 61	0	+ 12									
$\Delta^3\, T_6$	+ 256	— 398	+ 256												
$\Delta^3\, U_6$	— 16	+ 82	— 16												
$\Delta^2\,\Delta'\, U_6$	— 16	+ 2	— 16												
$\Delta\,\Delta''\, V_6$	0	— 16	0												

$$\Delta^4\, T_6 = 256\, \alpha\, g_{\frac{3}{2}}$$

$$\Delta^3\, \Delta'\, U_6 = -\, 18\, \alpha\, g_{\frac{3}{2}}$$

As before explained this table gives, for example, $-\,\Delta^2\,\Delta'\,\overset{i}{U_6} = (2\,i - 16)\,\alpha\, g^i_{\frac{3}{2}} - 16\,\alpha^2 D_\alpha\, g^i_{\frac{3}{2}}$

TABLE IV.

$b_{\frac{5}{2}}$	α^2	$i\,\alpha^2$	$\alpha^3 D_\alpha$	$i^2 \alpha^2$	$i\,\alpha^3 D_\alpha$	$\alpha^4 D^2_\alpha$
W_6	+ 8	+ 13	— 6	+ 4	— 4	+ 1
X_6	— 10	— 16	+ 6	— 4	0	+ 1
$\Delta\, W_6$	— 22	— 23	+ 12			
$\Delta'\, W_6$	+ 12	— 32	+ 16			
$\Delta\,\Delta'\, W_6$	— 4	+ 32	— 16			
$\Delta\, X_5$	0	+ 16	0			
$\Delta'\, X_6$	+ 52	+ 2	+ 8			
$\Delta^2\, W_6$	+ 104					
$\Delta^2\,\Delta'\, W_6$	— 72					
$\Delta^2\, X_6$	0					
$\Delta\,\Delta'\, X_6$	— 64					

TABLE V.

$g_{\frac{5}{2}}$	α^2	$i\,\alpha^2$	$\alpha^3 D_\alpha$	$i^2 \alpha^2$	$i\,\alpha^3 D_\alpha$	$\alpha^4 D^2_\alpha$
Y_6	— 1	+ 5	— 2	+ 4	— 4	+ 1
Z_6	+ 2	— 8	+ 6	— 4	0	+ 1
$\Delta\, Y_6$	+ 1	— 15	+ 8			
$\Delta'\, Y_6$	+ 6	— 16	+ 8			
$\Delta\,\Delta'\, Y_6$	— 2	+ 16	— 8			
$\Delta\, Z_6$	0	+ 8	0			
$\Delta'\, Z_6$	+ 18	+ 2	+ 4			
$\Delta^2\, Y_6$	+ 38					
$\Delta^2\,\Delta'\, Y_6$	— 36					
$\Delta^2\, Z_6$	0					
$\Delta\,\Delta'\, Z_6$	— 16					

TABLE VI.

$h_{\frac{5}{2}}$	α^2	$i\,\alpha^2$	$\alpha^3 D_\alpha$	$i^2 \alpha^2$	$i\,\alpha^3 D_\alpha$	$\alpha^4 D^2_\alpha$
$\mathbf{A}_6$	— 2	— 3	+ 2	+ 4	— 4	+ 1
$\mathbf{B}_6$	+ 6	0	+ 6	— 4	0	+ 1
$\Delta\, \mathbf{A}_5$	+ 8	— 7	+ 4			
$\Delta\, \mathbf{B}_6$	0	+ 2	0			
$\Delta^2\, \mathbf{A}_6$	+ 4					

FROM A LETTER OF MR. WEYER, OF THE HAMBURG OBSERVATORY, TO THE EDITOR.

[Translation.]

Hamburg, December 28th, 1849.

The following are corrected parabolic elements for the comet of Goujon, computed from three normal places (twenty-six observations in all), the two extreme places being at an interval of five months, April to September.

Perihelion Passage,	1849, May 26^{d}.53342, M. Berlin T.
Longitude of Perihelion,	235° 43′ 23″.7
Longitude of Ascending Node,	202 32 56.4
Inclination,	67 9 38.5
Log. Perihelion Distance,	0.0642040
Motion Direct.	

This parabola passes precisely through the extreme places, and represents the middle group for June 28th, (composed of eleven observations,) as follows: —

Calc. — Obs.	
$\Delta\,\alpha\cos\delta$	$\Delta\,\delta$
— 4″.7	+ 4″.2

The errors are divided between the two coördinates, in such a way that the sum of their squares is a minimum, and farther changes of the elements can only be derived from the discussion of all the intermediate observations, of which there are about three hundred.

GEORGE WEYER.

FROM A LETTER OF DR. H. D'ARREST TO THE EDITOR.

[Translation.]

Pleissenburg, *Leipsic*, *December* 30, 1849.

The news which you sent us, of the fortunate rediscovery * of the Schweizer comet in Cambridge, has interested me much, since the question as to the identity of the comets 1748 II. and 1849 II. must by this be decisively settled; — for a period of revolution so small as one hundred years would become very apparent in an orbital motion of 152°.

Moreover, the circumstance that these new observations agreed so very nearly with my last parabolic orbit, (Mr. Schweizer's most probable parabola showed a somewhat larger discrepancy in declination,) made this suspicion, which was certainly a natural one in May last, appear to me very improbable.

The following elliptic elements may, I think, be relied on, notwithstanding the uncertainty of the semi-axis major: —

Perihelion Passage, 1849, June $8^{d}.24086$ M. T. Berlin.

Log. q · · · · ·	9.951525	
Log. a · · · · ·	2.615310	
e · · · · ·	0.997830	
π · · · · ·	267° 6′ 7″.9	M. Equinox, 1849.0.
☊ · · · ·	30 32 0.1	
i · · · · ·	66 55 19.4	
Period, · · · · ·	8375 years.	

We have been occupied of late chiefly with Astræa and Hygea. Although you doubtless remember the small means with which our University-Observatory is provided, you will still probably agree with me, that the regular following up of the newly discovered small planets, through their oppositions, ought, however difficult, to be an object of my constant endeavors; and the more so, as the result has proved that the means at my disposal are sufficient to enable me to make such observations with satisfactory precision. Moreover, observations of this kind are liable to become less numerous, as the excitement of novelty decreases. As to the former, Astræa, I am not aware of any place where the oppositions of this planet were observed in 1847, 1848, and 1849, except in Berlin and Hamburg.† But of late, I have been observing it myself.

Hygea has given us some trouble, since we were able to follow it so short a time after the discovery, and since the Naples observations have not proved of greater value. Besides this, the faintness will render the finding of the planet at the beginning of next year very difficult.

The ephemeris of Hygea for 1850, published in the Berlin *Astr. Jahrbuch* for 1852, is founded upon my second elements (*Astr. Nachr.*, No. 680, p. 126), to which I have only applied the perturbations by Jupiter. You remember that I had compared with these elements all the observations received up to the close of the Berlin observations, and found a satisfactory agreement. In the mean time, Professor Challis has been enabled to continue the observations with the Northumberland telescope a month later, and has thus furnished occasion for a third and a fourth correction of the orbit. An ephemeris based upon the last determination, you will find in due time in the *Astronomische Nachrichten*. The rediscovery can hardly be expected before February or March. The planet will be very far south, and since your observatories have so low latitudes, you will probably precede us in the detection of the planet. You will, of course, be prepared for an uncommonly large deviation from the ephemeris.

I have just finished a tolerably complete series of observations of moon-culminating stars, which will, I trust, confirm my last determination of the longitude of our Observatory.

The following are from my observations of Astræa in the opposition of 1849. The planet was of the 9.10 magnitude.

1849.	M. T. Leipsic. d. h. m. s.	A.R. ° ′ ″	Decl. ° ′ ″	Comp.
Nov.	6 11 5 7.0	50 5 18.3	+9 15 44.8	14
	11 11 4 12.4	48 54 22.1	8 53 59.1	12
	12 7 55 25.0	48 41 52.6	8 50 20.7	12
	12 13 7 56.3	48 38 35.2	. . . .	9
	19 9 40 46.8	46 59 56.0	8 23 43.4	12
	19 11 16 55.1	46 58 56.1	8 23 38.2	5
	22 11 24 53.1	46 17 7.7	+8 13 59.2	15

The error in my Astræa-Elements IV. was at this opposition almost exactly two minutes in right ascension, so that a new correction of the elements is requisite for the next opposition (1851). The Elements IV. were based upon the observations up to 1847.

The following occultations, during the last few months, have not yet been published: —

1849.			M. T. Leipsic. h. m. s.
July 12,	f Piscium	Imm.	12 59 25.3
		Em.	13 49 42.0
Sept. 8,	71 Tauri	Imm.	10 45 59.4
"	θ^2 "	Imm.	11 51 27.0
"	80 "	Imm.	12 19 44.5
"	81 "	Imm.	12 33 1.2
"	θ^2 "	Em.	12 35 32.0
"	85 "	Imm.	13 7 10.9
"	81 "	Em.	13 30 23.3

* By Mr. Bond of the Cambridge Observatory. G.

† Astræa has been observed at the Washington Observatory, during the oppositions of 1847 and 1849. A series of observations at the opposition of 1847 appears on the following page. G.

1849.			M. T. Leipsic. h. m. s.
Oct. 5,	γ Tauri	Imm.	14 46 9.9
		Em.	16 0 10.2 (two obs. m.)
Oct. 25,	154 Aquarii	Imm.	6 31 56.8 (two obs. m.)
Oct. 28,	p Piscium	Em.	5 59 19.6
"	q Piscium	Imm.	6 56 27.7
		Em.	8 2 55.1 (very cloudy.)
Dec. 5,	ϱ Leonis	Imm.	11 28 33.7 (two obs. m.)

1849			M. T. Leipsic. h. m. s.
Dec. 5,	ϱ Leonis	Em.	12 27 3.8
Dec. 6,	♃, I. Sat.	Imm.	19 45 18.8
	I. Limb	Imm.	19 47 58.7 (three obs.)
	II. Limb	Imm.	19 50 15.8 (three obs.)
	II. Sat.	Imm.	19 50 23.4
	♃, II. Limb	Em.	20 31 48.9 (three obs. m.)

H. D'ARREST.

OBSERVATIONS OF ASTRÆA, 1847.

The following observations were made by Professor J. S. Hubbard, with the Filar-micrometer of the Washington Equatorial. The differences between the planet and stars are given as observed; the apparent places of the planet have been corrected for refraction and parallax, but not for aberration.

Date.	M. T. Washington.	Star of Comparison.	⚴ — ✱ $\Delta\alpha$	No. of Obs	$\Delta\delta$	No. of Obs.	⚴'s apparent α	δ
1847.	h. m. s.		m. s		′ ″		h. m. s.	° ′ ″
April 6	14 0 53.1	a	— 1 56.468	5	+ 1 34.89	5	16 7 22.77	— 12 57 42.6
	22 42.3	b	— 2 6.040	5	+ 5 57.96	5	7 22.32	57 40.5
7	13 4 39.6	a	— 2 10.728	6	+ 4 48.10	6	7 8.48	54 29.3
	14 11.5	b	— 2 20.353	6	+ 9 9.86	6	7 7.95	54 28.5
9	14 27 12.7	a	— 2 46.782	5	+ 11 56.50	5	6 32.58	47 20.5
11	13 52 14.6	c	+ 0 41.489	7	— 2 5.01	7	5 50.05	40 21.8
14	12 3 20.4	c	— 0 32.262	4	+ 8 34.79	4	4 36.25	29 41.7
	21 30.8	e	+ 5 25.450	1	— 9 58.84	1	4 34.86	29 40.7
	43 0.6	f	+ 3 10.020	3	— 0 59.80	3	4 34.92	29 37.2
15	13 36 19.4	f	+ 2 40.551	10	+ 2 52.05	10	4 5.53	25 45.0
16	13 41 7.4	f	+ 2 9.917	12	+ 6 37.66	12	3 34.92	21 59.2
18	13 52 38.7	f	+ 1 4.285	11	+ 14 13.22	11	2 29.35	14 23.3
20	12 42 20.0	e	+ 2 10.153	10	+ 12 43.15	10	1 19.69	— 12 6 57.3
22	13 16 6.2	g	+ 1 53.332	5	+ 5 6.40	5	16 0 2.04	— 11 59 10.9
26	13 43 38.6	h	+ 1 8.794	5	— 17 49.35	5	15 57 10.30	43 39.0
30	14 6 38.5	h	— 2 0 305	6	— 2 29.85	6	54 1.32	28 19.2
May 5	13 19 16.3	i	— 6 14.362	6	— 13 9.90	6	49 46.26	9 54.8
6	13 1 1.6	j	— 2 22.065	2	— 17 7.13	3	48 53.33	6 22.8
7	13 13 22.3	j	— 3 16.774	5	— 13 31.78	5	47 58.66	— 11 2 47.2
16	13 0 29.4	l	— 3 2.496	8	— 2 19.81	8	39 35.98	— 10 33 41.8
17	12 51 17.7	l	— 3 58.624	5	+ 0 30.85	5	38 39.86	— 10 30 50.8
June 6	13 16 3.2	n	+ 5 51.076	5	— 10 9.34	5	21 48.79	— 9 56 14 8
8	13 13 58.6	n	+ 4 31.278	5	— 9 24.75	5	20 29.00	55 30.0
11	13 36 8.5	n	+ 2 40.053	9	— 9 14.71	9	18 37.79	55 20.1
14	11 59 11.5	n	+ 1 4.272	5	— 10 16.48	5	15 17 1.95	— 9 56 21.3

The following are the adopted mean places of the stars of comparison, referred to the mean equinox of 1850.0 : —

Star.	α	No. of Obs	δ	No. of Obs	Authority.
	h. m. s.		° ′ ″		
a	16 9 27.17	10	— 12 59 48.78	10	Filar-micrometer. Compared with d.
b	9 36.27	5	13 4 9.93	5	" " " " a.
c	5 16.31	7	12 38 48.57	5	" " " " e.
d	–6 45.63	13	50 32.34	13	" " " " c.
e	15 59 17.10		20 13.85		Bradley, Lalande, Piazzi, Taylor, Henderson.
f	16 1 32.60	20	29 9.65	20	Filar-micrometer. Compared with e.
g	15 58 16.16	5	— 12 4 50.48	5	" " " " e.

Star.	α	No. of Obs.	δ	No. of Obs.	Authority.
h	h. m. s. 15 56 8.80		° ′ ″ — 11 26 22.36		Lalande.
i	56 7.71		10 57 17.91		Bradley, Lalande, Piazzi, Bessel, Pond, Taylor, Henderson.
j	51 22.48	6	49 49.22	6	Filar-micrometer. Compared with i.
k	45 59.87		38 30.64		Rümker.
l	42 45.35	o. 7 q. 5	31 57.53	o. 7 q. 5	Filar-micrometer. Compared with k and m.
m	35 2.92		26 22.80		Rümker.
n	15 16 4.34		— 9 46 44.59		Bradley, Lalande, Piazzi, Bessel, Taylor, Rümker, Henderson.

ON UNLIMITED SPHERICAL TRIANGLES AND THEIR SOLUTION.

By WILLIAM CHAUVENET,

PROFESSOR OF MATHEMATICS IN THE U. S. NAVAL SCHOOL.

I.

One of the characteristic features of modern spherical astronomy is to be found in the practice (introduced by Gauss) of considering spherical triangles in a general manner, i. e. without limiting their sides and angles to values less than 180°. But, notwithstanding the elegance and generality thus given to the solutions of many astronomical problems, nothing is to be found upon this subject in our trigonometrical works, where we should expect to find it fully treated. It is to be presumed, that the German mathematicians have not failed to develop it; but I have not been able to find any complete discussion of the several cases, and of the conditions which render the solution of each case determinate. It is possible, therefore, that, in the following remarks, I shall not advance any thing new, but I may at least serve the convenience of computers, who may wish to avail themselves of these processes, by bringing together such solutions as are well known, completing those which, as far as I can learn, have not been fully considered, and arranging them all in a convenient form for reference and use in practice.

I shall premise some general considerations which appear to be required to give a complete view of this subject.

II.

Of the various Triangles formed by the same Three Points of the Sphere.

1. If any two points, A and B, be taken upon the surface of the sphere, the arc of a great circle joining them may be considered to be either the arc $A\,B$ ($< 180°$), or $360° - A\,B$; or if we do not limit the arc to values less than a circumference, we may consider it to have an indefinite number of values expressed generally by the formula $2\,n\,\pi \pm \alpha$, α denoting that value which is less than π or a semicircumference, and n any whole number or zero.

2. If two arcs of great circles intersect in a point A, the angle which they form may be considered to be either the angle A ($< 90°$), or $180° - A$, or $180° + A$, or $360° - A$; or, taking the most general view of angular magnitude, the angle will have an indefinite number of values expressed by the formula $m\,\pi \pm A$, A denoting the value which is less than $\frac{1}{2}\pi$, and m any whole number, or zero.

3. If, therefore, any three points, A, B, C, be taken on the surface of the sphere, and great circles be made to pass through each pair, we shall have an infinite series of triangles whose sides will be generally expressed by

$$2\,n\,\pi \pm a, \quad 2\,n\,\pi \pm b, \quad 2\,n\,\pi \pm c, \qquad (1)$$

and whose angles will be generally expressed by

$$m\,\pi \pm A, \quad m\,\pi \pm B, \quad m\,\pi \pm C; \qquad (2)$$

a, b, c, denoting the arcs less than π joining the pairs of points $B\,C$, $A\,C$, $A\,B$, respectively; A, B, C, the angles less than $\frac{1}{2}\pi$ formed at those points by the intersection of these arcs; and n and m, any whole numbers, or zero.

4. It is evident, however, that we cannot assume that any three values of the sides from the series (1), combined with any three values of the angles from (2), will form a spherical triangle. Some general relations of the parts composing a triangle must first be established, from which corresponding values of n and m in (1) and (2) may be deduced. Although these general relations are well known, it may not be out of place to add here a concise demonstration of them.

Let the point C, one of the angular points of the spherical triangle $A\,B\,C$, be referred by rectangular coordinates to three planes, one of which, the plane of $x\,y$, is the plane of the great circle $A\,B$; let the axis of x be the diameter of the sphere

passing through B, and let the origin be the center of the sphere. The formulas of transformation from these coördinates to polar coördinates, the origin being the same, the polar axis being the axis of x, and the fixed plane the plane of $x\,y$, are

$$\left.\begin{aligned} x &= R\cos a \\ y &= R\sin a\cos B \\ z &= R\sin a\sin B \end{aligned}\right\} \qquad (3)$$

where B denotes the angle which the plane passing through the polar axis and the point C makes with the fixed plane; R, the radius-vector in this plane, or distance of the point C from the origin; and a the angle which this radius-vector makes with the polar axis. B is an angle of the spherical triangle, and a is the side opposite the angle A; and, according to the principles of analytical geometry, B and a may be altogether unlimited, due regard being had to the signs of their trigonometric functions and to those of x, y, and z.

Let us now transform from these rectangular coördinates to others also rectangular, the origin and the plane of $x\,y$ remaining the same, but the axis of x in the new system passing through the point A, and therefore making with the first axis the angle c, c also expressing the side of the triangle opposite the angle C. The known formulas of transformation become

$$\left.\begin{aligned} x &= x'\cos c - y'\sin c \\ y &= x'\sin c + y'\cos c \\ z &= z' \end{aligned}\right\} \qquad (4)$$

Finally, the formulas of transformation from this last system of rectangular again to polar coördinates, the origin being the same, the fixed plane the plane of $x'\,y'$, and the polar axis the axis of x', are

$$\left.\begin{aligned} x' &= R\cos b \\ y' &= -R\sin b\cos A \\ z' &= R\sin b\sin A \end{aligned}\right\} \qquad (5)$$

Now, if the values of x, y, z, x', y', z', given by (3) and (5) be substituted in (4), we have at once the following system of equations: —

$$\left.\begin{aligned} \cos a &= \cos c\cos b + \sin c\sin b\cos A \\ \sin a\cos B &= \sin c\cos b - \cos c\sin b\cos A \\ \sin a\sin B &= \sin b\sin A \end{aligned}\right\} \qquad (6)$$

which are the known fundamental formulas of spherical trigonometry, but established without imposing any restrictions upon the values of the parts of the triangle.

From this investigation, it appears that these formulas may be regarded as formulas of transformation from one system of polar coördinates to another, or rather, from one system of spherical coordinates to another. For example, the coördinates of a star referred to the pole of the equator and the meridian of a place whose colatitude is c, are its polar distance σ, and its hour-angle B; the coördinates of the same star referred to the pole of the horizon and the meridian, are its zenith distance b, and its azimuth A; and the formulas (6) express the relations by means of which we can pass from one of these systems to the other.

4. Let us now inquire what are the corresponding values of the sides and angles in the series of triangles expressed by (1) and (2). Let a, b, c, A, B, C, denote the values of the parts of *one* of these triangles, which, if we please, we may suppose to be the triangle whose parts are all less than π. Then, since

$$\sin(2n\pi + \varphi) = \sin\varphi, \quad \cos(2n\pi + \varphi) = \cos\varphi,$$

the equations (6) will be satisfied by the substitution of $2n\pi + a$, $2n\pi + b$, &c., for a, b, and c; and therefore the triangle (a, b, c, A, B, C) is the first of an infinite series obtained from it by the successive addition of 2π to each or all of its parts, every triangle of the series being such, that the relations of its parts are expressed by (6), when a, b, c, A, B, C, are assumed to represent those parts.

(*To be continued.*)

CORRIGENDA.

Page 3, lines —6 and —7, for $b_{\frac{3}{2}}^{(i)}$ read $\alpha\, b_{\frac{3}{2}}^{(i)}$.

" 19, line 16, for 22° 4′ 5″.6 read 22° 4′ 55″.6.

" 29, " —6, " —24′ 10″.91 " —0′ 10″.91.

Page 30, throughout, *for* W. C. *read* Weisse C.

" 31, line —6, add $+\frac{1}{768}\, e\, e'^{5}\, \Sigma^{3} \,.\, \Sigma' \,.\, M_6$.

" 32, " 10, for e^2 read e'.

" 32, line —4, in some copies, *for* $74^{m.}$ *read* $47^{m.}$

CONTENTS.

THE

ASTRONOMICAL JOURNAL.

No. 6.

VOL. I. CAMBRIDGE, MARCH 27, 1850. NO. 6.

ON UNLIMITED SPHERICAL TRIANGLES AND THEIR SOLUTION.

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(*Continued from page* 40.)

It is evident, also, from the principle of "uniformity of direction" observed in the preceding demonstration in reckoning the sides and angles, that we must be able to satisfy the equations, by making either all the sides, or all the angles, or all the sides and angles, *negative at the same time;* and, considering each of the triangles thus obtained as the first of a series, as above, we have three more series. We have then the four series following: —

1st Series.	2d Series.	3d Series.	4th Series.
$2n\pi+a, 2n\pi+A$	$2n\pi-a, 2n\pi+A$	$2n\pi+a, 2n\pi-A$	$2n\pi-a, 2n\pi-A$
$2n\pi+b, 2n\pi+B$	$2n\pi-b, 2n\pi+B$	$2n\pi+b, 2n\pi-B$	$2n\pi-b, 2n\pi-B$
$2n\pi+c, 2n\pi+C$	$2n\pi-c, 2n\pi+C$	$2n\pi+c, 2n\pi-C$	$2n\pi-c, 2n\pi-C$

In all the terms of these series n may have the same or different values; and we thus have all the possible combinations of the values represented by (1) and (2), *so long as* m *in* (2) *is even.* But if we substitute $2n+1$ for m we shall find that the following series will satisfy the equations (6): —

5th Series.	6th Series.	7th Series.	8th Series.
$2n\pi+a, 2n\pi+A$	$2n\pi-a, 2n\pi+A$	$2n\pi+a, 2n\pi-A$	$2n\pi-a, 2n\pi-A$
$2n\pi-b, (2n+1)\pi+B$	$2n\pi+b, (2n+1)\pi+B$	$2n\pi-b, (2n+1)\pi-B$	$2n\pi+b, (2n+1)\pi-B$
$2n\pi-c, (2n+1)\pi+C$	$2n\pi+c, (2n+1)\pi+C$	$2n\pi-c, (2n+1)\pi-C$	$2n\pi+c, (2n+1)\pi-C$

the 6th, 7th, and 8th of which series are derived from the 5th, as the 2d, 3d, and 4th were derived from the 1st, in the preceding paragraph.

By successively exchanging a for b and c, we find eight more series, namely, —

9th Series.	10th Series.	11th Series.	12th Series.
$2n\pi-a, (2n+1)\pi+A$	$2n\pi+a, (2n+1)\pi+A$	$2n\pi-a, (2n+1)\pi-A$	$2n\pi+a, (2n+1)\pi-A$
$2n\pi+b, 2n\pi+B$	$2n\pi-b, 2n\pi+B$	$2n\pi+b, 2n\pi-B$	$2n\pi-b, 2n\pi-B$
$2n\pi-c, (2n+1)\pi+C$	$2n\pi+c, (2n+1)\pi+C$	$2n\pi-c, (2n+1)\pi-C$	$2n\pi+c, (2n+1)\pi-C$

13th Series.	14th Series.	15th Series.	16th Series
$2n\pi-a, (2n+1)\pi+A$	$2n\pi+a, (2n+1)\pi+A$	$2n\pi-a, (2n+1)\pi-A$	$2n\pi+a, (2n+1)\pi-A$
$2n\pi-b, (2n+1)\pi+B$	$2n\pi+b, (2n+1)\pi+B$	$2n\pi-b, (2n+1)\pi-B$	$2n\pi+b, (2n+1)\pi-B$
$2n\pi+c, 2n\pi+C$	$2n\pi-c, 2n\pi+C$	$2n\pi+c, 2n\pi-C$	$2n\pi-c, 2n\pi-C$

5. We might also have satisfied our equations by substitutions, such as $(2n+1)\pi + a$, &c., for a, &c.; but this introduces, in the place of the three points first considered, points diametrically opposite to them on the surface of the sphere. If we consider all the triangles thus formed, we are led to the following general conclusion. Since three great circles by their mutual intersections (provided they have not a common diameter), divide the surface of the whole sphere into eight primitive triangles (whose parts are all less than π), the three angular points of each of which give sixteen triangles, whose parts are all less than 2π, therefore, *three great circles of the sphere form in general one hundred and twenty-eight triangles, each of which may be considered as the first term of an infinite series of triangles formed from it by the successive addition of 2π to each or all of its parts.*

III.

Ambiguity in the Solution of the General Spherical Triangle.

For the sake of brevity, I shall call the spherical triangle, whose parts are only limited by the condition $< 360°$, *the general spherical triangle.* Although any three points of the surface of the sphere may be regarded (in general) as the angular points of sixteen such triangles, yet to the problem, "given three parts of the triangle to find the other three," there will in every case be but two solutions, i. e. two triangles containing the same data. From the equations (6), and the consequences that flow from them, we can always obtain expressions for both the sine and cosine of each of the required parts, which would fully determine the triangle, were it not that in every case one of these expressions at least involves a radical of the second degree, and has either two different numerical values, or two values numerically equal with opposite signs. To avoid this ambiguity it was thought expedient to limit all the parts of the triangle to values less than 180°, or to consider only the simple geometrical triangle. By this means all the cases in which the required quantities can be found by a cosine or tangent, without involving radicals, become fully determined. But this occurs in but four of the six cases, the other two still having two solutions; so that although six conditions were thus imposed, three limiting the data themselves, and three the quæsita, the object of removing all ambiguity was not reached.

We shall see from the solutions of the general triangle, that *the ambiguity is entirely removed in every case by the imposition of a single condition restricting the sign of either the sine or cosine of but one of the required parts.* The general method here, as in many other parts of the mathematics, is therefore the simplest.

IV.

Formulas required for the Solution of the General Spherical Triangle.

1. As the formulas (6) are the same as those deduced in trigonometrical works for limited spherical triangles, we may avail ourselves, for the solution of the general triangle, of all the formulas (found in those works), deduced from them in a general manner. It is not necessary therefore to repeat all these deductions here; but I shall add a demonstration of GAUSS's equations, slightly differing from the common one, in order to establish them in all their generality.

2. GAUSS's THEOREM. *If*

$$\begin{aligned} p &= \cos\tfrac{1}{2}c \sin\tfrac{1}{2}(A+B) & P &= \cos\tfrac{1}{2}C \cos\tfrac{1}{2}(a-b) \\ q &= \cos\tfrac{1}{2}c \cos\tfrac{1}{2}(A+B) & Q &= \sin\tfrac{1}{2}C \cos\tfrac{1}{2}(a+b) \\ r &= \sin\tfrac{1}{2}c \sin\tfrac{1}{2}(A-B) & R &= \cos\tfrac{1}{2}C \sin\tfrac{1}{2}(a-b) \\ s &= \sin\tfrac{1}{2}c \cos\tfrac{1}{2}(A-B) & S &= \sin\tfrac{1}{2}C \sin\tfrac{1}{2}(a+b) \end{aligned}$$

then the products p q, p r, p s, q r, q s, r s, *are respectively equal to the products* P Q, P R, P S, Q R, Q S, R S.

To demonstrate this, we have only to form the following equations, which are easily deduced from the fundamental formulas: —

$$\sin c\,(\sin A \pm \sin B) = \sin C\,(\sin a \pm \sin b)$$
$$\sin c\,(\cos A \pm \cos B) = (1 \mp \cos C)\sin(a \pm b)$$
$$(1 \pm \cos c)\sin(A \pm B) = \sin C\,(\cos b \pm \cos a)$$

which, transformed by the formulas of the trigonometric analysis, give respectively

$$\begin{aligned} ps &= PS & qr &= QR \\ qs &= QS & pr &= PR \\ pq &= PQ & rs &= RS. \end{aligned}$$

3. *The same notation being employed, the quantities* p^2, q^2, r^2, s^2, *are respectively equal to the quantities* P^2, Q^2, R^2, S^2.

For we have $pq \times pr = PQ \times PR$ and $qr = QR$, whence by division, $p^2 = P^2$, and in the same way $q^2 = Q^2$, $r^2 = R^2$, $s^2 = S^2$.

4. GAUSS's EQUATIONS. From the preceding paragraph we deduce

$$p = \pm P$$
$$q = \pm Q$$
$$r = \pm R$$
$$s = \pm S$$

In these equations the positive sign must be taken in all the second members at the same time, or the negative sign in all of them.

For if we take $p = +P$, the equations $pq = PQ$, $pr = PR$, $ps = PS$, being divided by this, give $q = +Q$, $r = +R$, $s = +S$. But if we take $p = -P$, the same equations divided by this, give $q = -Q$, $r = -R$, $s = -S$.

Hence the two following groups of equations, the first group comprising those commonly known as GAUSS's equations: —

$$\left.\begin{aligned}\cos\tfrac{1}{2}c\sin\tfrac{1}{2}(A+B)&=\cos\tfrac{1}{2}C\cos\tfrac{1}{2}(a-b)\\ \cos\tfrac{1}{2}c\cos\tfrac{1}{2}(A+B)&=\sin\tfrac{1}{2}C\cos\tfrac{1}{2}(a+b)\\ \sin\tfrac{1}{2}c\sin\tfrac{1}{2}(A-B)&=\cos\tfrac{1}{2}C\sin\tfrac{1}{2}(a-b)\\ \sin\tfrac{1}{2}c\cos\tfrac{1}{2}(A-B)&=\sin\tfrac{1}{2}C\sin\tfrac{1}{2}(a+b)\end{aligned}\right\}\quad(7)$$

$$\left.\begin{aligned}\cos\tfrac{1}{2}c\sin\tfrac{1}{2}(A+B)&=-\cos\tfrac{1}{2}C\cos\tfrac{1}{2}(a-b)\\ \cos\tfrac{1}{2}c\cos\tfrac{1}{2}(A+B)&=-\sin\tfrac{1}{2}C\cos\tfrac{1}{2}(a+b)\\ \sin\tfrac{1}{2}c\sin\tfrac{1}{2}(A-B)&=-\cos\tfrac{1}{2}C\sin\tfrac{1}{2}(a-b)\\ \sin\tfrac{1}{2}c\cos\tfrac{1}{2}(A-B)&=-\sin\tfrac{1}{2}C\sin\tfrac{1}{2}(a+b)\end{aligned}\right\}\quad(8)$$

5. Now when the parts of the triangle are limited to values less than 180°, the second of these groups is excluded, since $\cos\frac{1}{2}c$, $\sin\frac{1}{2}(A+B)$, $\cos\frac{1}{2}C$, $\cos\frac{1}{2}(a-b)$ are then all positive. But when the triangle is unlimited, both groups must be admitted, and the question arises, when are we to employ the positive, and when the negative sign? Gauss himself has remarked (*Theoria Mot. Corp. Cœl.*, Art. 54), that cases occur in practice in which it is necessary to employ the negative sign, and promises elsewhere a fuller explanation, which, however, I have not been able to find. But the nature of these cases and the answer to the question above propounded will be easily inferred from the following considerations.

We have seen that the formulas (6) apply not only to the triangle whose parts, a, b, c, A, B, C, are all less than 360° or 2π, but also to all the triangles whose parts are $2n\pi+a$, $2n\pi+b$, $2n\pi+c$, $2n\pi+A$, $2n\pi+B$, $2n\pi+C$, n being any whole number or zero, and admitting of different values in each of the parts. Let us, therefore, substitute in (7) the following values of these parts: —

$$\begin{array}{ll} 2n_1\pi+a, & 2m_1\pi+A,\\ 2n_2\pi+b, & 2m_2\pi+B,\\ 2n_3\pi+c, & 2m_3\pi+C. \end{array}$$

We shall have for the factors of the first members the values: —

$$\cos(n_3\pi+\tfrac{1}{2}c)=(-1)^{n_3}\cos\tfrac{1}{2}c$$
$$\sin(n_3\pi+\tfrac{1}{2}c)=(-1)^{n_3}\sin\tfrac{1}{2}c$$
$$\cos\left[(m_1+m_2)\pi+\tfrac{1}{2}(A+B)\right]=(-1)^{m_1+m_2}\cos\tfrac{1}{2}(A+B)$$
$$\sin\left[(m_1+m_2)\pi+\tfrac{1}{2}(A+B)\right]=(-1)^{m_1+m_2}\sin\tfrac{1}{2}(A+B)$$
$$\cos\left[(m_1-m_2)\pi+\tfrac{1}{2}(A-B)\right]=(-1)^{m_1-m_2}\cos\tfrac{1}{2}(A-B)$$
$$\sin\left[(m_1-m_2)\pi+\tfrac{1}{2}(A-B)\right]=(-1)^{m_1-m_2}\sin\tfrac{1}{2}(A-B)$$

Now whatever the values of m_1 and m_2, m_1+m_2 and m_1-m_2 are both even or both odd at the same time, and therefore *the above substitution gives the same sign to all the first members of our equations.* In the same way it is shown that the second members will all have the same sign; and we may consequently express the result of the substitution thus: —

$$\cos\tfrac{1}{2}c\sin\tfrac{1}{2}(A+B)=(-1)^n\cos\tfrac{1}{2}C\cos\tfrac{1}{2}(a-b)$$
$$\cos\tfrac{1}{2}c\cos\tfrac{1}{2}(A+B)=(-1)^n\sin\tfrac{1}{2}C\cos\tfrac{1}{2}(a+b)$$
$$\sin\tfrac{1}{2}c\sin\tfrac{1}{2}(A-B)=(-1)^n\cos\tfrac{1}{2}C\sin\tfrac{1}{2}(a-b)$$
$$\sin\tfrac{1}{2}c\cos\tfrac{1}{2}(A-B)=(-1)^n\sin\tfrac{1}{2}C\sin\tfrac{1}{2}(a+b)$$

which single group involves both (9) and (8). It follows that *it is only by giving* Gauss's *equations the double sign that they express the relations of the parts of all the triangles obtained by the successive addition of 2π to each of the parts of the primitive triangle, whose parts are all less than 2π. The group (7) will represent one series of triangles, while the group (8) will represent another series, and the primitive triangle may belong to one or the other of these series.*

It follows, also, that *in the practical application of these equations, we may employ the positive sign only and dispense with the group* (8). For we shall thus always obtain either the triangle sought, or one whose parts differ from those of the triangle sought by 2π, or some multiple of 2π; therefore, by the subtraction of 2π, when necessary, we can always arrive at the values which would have been obtained directly by the employment of the group with the negative sign. This conclusion agrees with the practical precept laid down by Gauss in the article already referred to.

6. When the parts of the triangle are interchanged in Gauss's equations, it would seem to require proof that the same sign, whether $+$ or $-$, must continue in these equations; i. e. that when the triangle is such as to satisfy the equation,

$$\cos\tfrac{1}{2}c\sin\tfrac{1}{2}(A+B)=\cos\tfrac{1}{2}C\cos\tfrac{1}{2}(a-b)$$

it will also satisfy the equations,

$$\left.\begin{aligned}\cos\tfrac{1}{2}b\sin\tfrac{1}{2}(A+C)&=\cos\tfrac{1}{2}B\cos\tfrac{1}{2}(a-c)\\ \cos\tfrac{1}{2}a\sin\tfrac{1}{2}(B+C)&=\cos\tfrac{1}{2}A\cos\tfrac{1}{2}(b-c)\end{aligned}\right\}\quad(e)$$

and that when it is such as to satisfy the equation,

$$\cos\tfrac{1}{2}c\sin\tfrac{1}{2}(A+B)=-\cos\tfrac{1}{2}C\cos\tfrac{1}{2}(a-b)$$

it will also satisfy the equations,

$$\left.\begin{aligned}\cos\tfrac{1}{2}b\sin\tfrac{1}{2}(A+C)&=-\cos\tfrac{1}{2}B\cos\tfrac{1}{2}(a-c)\\ \cos\tfrac{1}{2}a\sin\tfrac{1}{2}(B+C)&=-\cos\tfrac{1}{2}A\cos\tfrac{1}{2}(b-c)\end{aligned}\right\}\quad(f)$$

To demonstrate this, we will show that the groups to which the equations (e) belong may be derived from (7) and those to which (f) belong from (8), by merely linear transformations, and therefore without again introducing the double sign. Let the equations (7) be written thus: —

$$\left.\begin{aligned}\frac{\sin\frac{1}{2}(A+B)}{\cos\frac{1}{2}C}&=\frac{\cos\frac{1}{2}(a-b)}{\cos\frac{1}{2}c}\\ \frac{\cos\frac{1}{2}(A+B)}{\sin\frac{1}{2}C}&=\frac{\cos\frac{1}{2}(a+b)}{\cos\frac{1}{2}c}\\ \frac{\sin\frac{1}{2}(A-B)}{\cos\frac{1}{2}C}&=\frac{\sin\frac{1}{2}(a-b)}{\sin\frac{1}{2}c}\\ \frac{\cos\frac{1}{2}(A-B)}{\sin\frac{1}{2}C}&=\frac{\sin\frac{1}{2}(a+b)}{\sin\frac{1}{2}c}\end{aligned}\right\}\quad(g)$$

The sum and difference of the first two, and the sum and difference of the last two, give

$$\frac{\cos\frac{1}{2}(A+B+C)}{\sin C}=-\frac{\sin\frac{1}{2}a\sin\frac{1}{2}b}{\cos\frac{1}{2}c}$$
$$\frac{\cos\frac{1}{2}(A+B-C)}{\sin C}=\frac{\cos\frac{1}{2}a\cos\frac{1}{2}b}{\cos\frac{1}{2}c}$$

$$\frac{\cos\frac{1}{2}(A-B+C)}{\sin C}=\frac{\cos\frac{1}{2}a\sin\frac{1}{2}b}{\sin\frac{1}{2}c}$$
$$\frac{\cos\frac{1}{2}(-A+B+C)}{\sin C}=\frac{\sin\frac{1}{2}a\cos\frac{1}{2}b}{\sin\frac{1}{2}c}$$

By differently combining these four equations, two and two, we may either reproduce the group (g) or the two groups represented by (e). Thus the sum and difference of the first and third, and of the second and fourth, give

$$\frac{\sin\frac{1}{2}B\sin\frac{1}{2}(A+C)}{\sin C}=\frac{\sin\frac{1}{2}b\cos\frac{1}{2}(a-c)}{\sin c}$$
$$\frac{\cos\frac{1}{2}B\cos\frac{1}{2}(A+C)}{\sin C}=\frac{\sin\frac{1}{2}b\cos\frac{1}{2}(a+c)}{\sin c}$$
$$\frac{\sin\frac{1}{2}B\sin\frac{1}{2}(A-C)}{\sin C}=\frac{\cos\frac{1}{2}b\sin\frac{1}{2}(a-c)}{\sin c}$$
$$\frac{\cos\frac{1}{2}B\cos\frac{1}{2}(A-C)}{\sin C}=\frac{\cos\frac{1}{2}b\sin\frac{1}{2}(a+c)}{\sin c}$$

These multiplied by

$$\frac{\sin C}{\sin B}=\frac{\sin c}{\sin b}$$

give

$$\frac{\sin\frac{1}{2}(A+C)}{\cos\frac{1}{2}B}=\frac{\cos\frac{1}{2}(a-c)}{\cos\frac{1}{2}b}$$
$$\frac{\cos\frac{1}{2}(A+C)}{\sin\frac{1}{2}B}=\frac{\cos\frac{1}{2}(a+c)}{\cos\frac{1}{2}b}$$
$$\frac{\sin\frac{1}{2}(A-C)}{\cos\frac{1}{2}B}=\frac{\sin\frac{1}{2}(a-c)}{\sin\frac{1}{2}b}$$
$$\frac{\cos\frac{1}{2}(A-C)}{\sin\frac{1}{2}B}=\frac{\sin\frac{1}{2}(a+c)}{\sin\frac{1}{2}b}$$

Precisely the same transformations applied to (8) would of course give a similar result with the negative sign. Hence,

In the three groups which Gauss's *equations form by the permutation of the letters, the positive sign must be taken in all the equations, or the negative sign in all of them.*

V.

Auxiliary Angles.

It will be convenient to premise here the following proposition, upon which depends the proper employment of auxiliary angles in preparing our general formulas for logarithmic computation.

From the equations

$$\left.\begin{aligned}K\sin\varphi&=m\\K\cos\varphi&=m\end{aligned}\right\}\qquad(9)$$

whatever the values of m *and* n, *we can always determine* K *and* φ *so as to satisfy at once these equations and any one of the following conditions arbitrarily imposed.*

1st K positive, ($\varphi<360°$),
2d K negative, ($\varphi<360°$),
3d $\varphi>0$ and $<180°$,
4th $\varphi>180°$ and $<360°$,
5th $\varphi<90°$ and $>-90°$,
6th $\varphi>90°$ and $<270°$.

The quotient of the equations (9), $\tan\varphi=\frac{m}{n}$, gives two values of φ under 360°. Hence, also, two values of K, which will be numerically equal with opposite signs, since the two values of $\sin\varphi$ will be numerically equal with opposite signs, as also the two values of $\cos\varphi$. If we restrict the sign of any one of the three quantities K, $\sin\varphi$, $\cos\varphi$, the signs of the other two will become known, and there will be but one value of K and one of φ under that restriction. The six conditions above stated are obviously equivalent to the following: — 1st, $K+$; 2d, $K-$; 3d, $\sin\varphi+$; 4th, $\sin\varphi-$; 5th, $\cos\varphi+$; 6th, $\cos\varphi-$. Of these six conditions, however, we commonly employ only the first, third, or fifth.

VI.

Solution of the Several Cases of the General Spherical Triangle.

In the solutions of the various cases of spherical triangles, it is of the first importance to have simple and clear precepts, both for removing the ambiguity that occurs in every case and for determining properly the auxiliary angles. Examples might be pointed out, in recent works on trigonometry, of incorrect numerical solutions resulting from an erroneous application of precepts, in themselves correct, but not sufficiently simple or explicit. I have, therefore, given special attention to this point in arranging the following solutions. These solutions have also been carefully verified by the computation of the two triangles following: —

First Triangle.

$a=$	125°	0′	0″	$A=$	264°	51′	30″.4
$b=$	140	0	0	$B=$	231	24	6.9
$c=$	46	0	0	$C=$	299	1	0.6

Second Triangle

$a=$	40°	0′	0″	$A=$	319°	21′	21″.4
$b=$	250	0	0	$B=$	107	46	57.6
$c=$	230	0	0	$C=$	50	55	9.3

The first of these triangles requires the positive sign in Gauss's Equations, and the second requires the negative sign.

1. *Given* b, c, *and* A, *to find* a *and* B. The general relations between the given and required parts are

$$\left.\begin{aligned}\cos a&=\cos c\cos b+\sin c\sin b\cos A\\ \sin a\cos B&=\sin c\cos b-\cos c\sin b\cos A\\ \sin a\sin B&=\sin b\sin A\end{aligned}\right\}\qquad(1)$$

The second members being computed, the numerical value and the sign of $\cos a$ will be determined from the first equation. From the second and third $\sin a$ and B are determined precisely

as K and φ in the preceding section (V.), and are subject to the same ambiguity. *The ambiguity will be removed, therefore, when the sign of either sin* a, *sin* B, *or cos* B *is given, and in like manner when the sign of either sin* C *or cos* C *is given.*

The solution may be adapted for logarithmic computation, and the condition required for removing the ambiguity may be varied.

Let K and φ be determined by the conditions (9), section V., taking $m = \sin b \cos A$, and $n = \cos b$, and adopting the first arbitrary condition; then the equations (1) assume the following form: —

$$\left.\begin{aligned} K\sin\varphi &= \sin b\cos A \\ K\cos\varphi &= \cos b \qquad (K \text{ positive}) \\ \cos a &= K\cos(c-\varphi) \\ \sin a\cos B &= K\sin(c-\varphi) \\ \sin a\sin B &= \sin b\sin A \end{aligned}\right\} \qquad (2)$$

Or, eliminating K and adopting the third condition of section V.,

$$\left.\begin{aligned} \tan\varphi &= \tan b\cos A \qquad (\varphi < 180^\circ) \\ \cos a &= \frac{\cos b}{\cos\varphi}\cos(c-\varphi) \\ \sin a\cos B &= \frac{\cos b}{\cos\varphi}\sin(c-\varphi) \\ \sin a\sin B &= \sin b\sin A \end{aligned}\right\} \qquad (3)$$

If the quadrant in which a *is to be taken is given*, then

$$\left.\begin{aligned} \tan\varphi &= \tan b\cos A \quad (\varphi < 180^\circ) \\ \tan a\cos B &= \tan(c-\varphi) \\ \tan a\sin B &= \frac{\sin\varphi\tan A}{\cos(c-\varphi)} \end{aligned}\right\} \qquad (4)$$

In (3) and (4) we may also limit φ to values numerically less than 90°, with the sign of the tangent according to the fifth arbitrary condition (V.).

If both a *and* b *are less than* 180°, as not unfrequently happens in the applications of this problem, let

$$m = \frac{K}{\sin b} \qquad\qquad n = \frac{\sin a}{K}$$

then m and n are both positive (K being positive) and the following form may be employed: —

$$\left.\begin{aligned} m\sin\varphi &= \cos A \\ m\cos\varphi &= \cot b \\ n\sin B &= \sin\varphi\tan A \\ n\cos B &= \sin(c-\varphi) \\ \cot a &= \cot(c-\varphi)\cos B \end{aligned}\right\} \qquad (5)$$

Check. For the purpose of verification we may employ with (4) or (5) the formula $\sin a \sin B = \sin b \sin A$; and with any of the preceding solutions the following check: —

$$\frac{\sin(c-\varphi)}{\sin\varphi} = \frac{\sin a\cos B}{\sin b\cos A} = \frac{\tan A}{\tan B}$$

2. *Given* b, c, *and* A, *to find* B *and* C. We employ GAUSS's equations as follows: —

$$\left.\begin{aligned} \cos\tfrac{1}{2}a\sin\tfrac{1}{2}(B+C) &= \cos\tfrac{1}{2}A\cos\tfrac{1}{2}(b-c) \\ \cos\tfrac{1}{2}a\cos\tfrac{1}{2}(B+C) &= \sin\tfrac{1}{2}A\cos\tfrac{1}{2}(b+c) \\ \sin\tfrac{1}{2}a\sin\tfrac{1}{2}(B-C) &= \cos\tfrac{1}{2}A\sin\tfrac{1}{2}(b-c) \\ \sin\tfrac{1}{2}a\cos\tfrac{1}{2}(B-C) &= \sin\tfrac{1}{2}A\sin\tfrac{1}{2}(b+c) \end{aligned}\right\} \qquad (6)$$

The first two determine $\frac{1}{2}(B+C)$ when the sign of $\cos\frac{1}{2}a$ is known, and the second two determine $\frac{1}{2}(B-C)$ when the sign of $\sin\frac{1}{2}a$ is known. *Hence, then, equations present no ambiguity when the sign of sin* a *is given*; for $\sin\frac{1}{2}a$ is always positive, and $\cos\frac{1}{2}a$ has the same sign as $\sin a$, according to the formula,

$$\sin a = 2\sin\tfrac{1}{2}a\cos\tfrac{1}{2}a$$

As explained in section IV., the equation (6) taken with the positive sign only may give values of B and C exceeding 360°, in which case the required solution will be found by diminishing such values by 360°.

3. *Given* B, C, *and* a, *to find* A *and* b. The general relations between the given and required parts are

$$\left.\begin{aligned} \cos A &= -\cos C\cos B + \sin C\sin B\cos a \\ \sin A\cos b &= \sin C\cos B + \cos C\sin B\cos a \\ \sin A\sin b &= \sin B\sin a \end{aligned}\right\} \qquad (7)$$

which determine A and b without ambiguity *when the sign of either* sin A, sin b, *or* cos b *is given.* In like manner the ambiguity is removed when the sign of either sin c or cos c is given.

Adapted for logarithms by the method already used, these equations become

$$\left.\begin{aligned} K\sin\varphi &= \sin B\cos a \\ K\cos\varphi &= \cos B \qquad (K \text{ positive}) \\ \cos A &= -K\cos(C+\varphi) \\ \sin A\cos b &= K\sin(C+\varphi) \\ \sin A\sin b &= \sin B\sin a \end{aligned}\right\} \qquad (8)$$

Or,

$$\left.\begin{aligned} &\tan\varphi = \tan B\cos a \; (\varphi < 180^\circ \text{ always positive; or } \varphi \text{ less than } 90^\circ \text{ with the sign of its tangent.}) \\ &\cos A = -\frac{\cos B}{\cos\varphi}\cos(C+\varphi) \\ &\sin A\cos b = \frac{\cos B}{\cos\varphi}\sin(C+\varphi) \\ &\sin A\sin b = \sin B\sin a \end{aligned}\right\} \qquad (9)$$

When the quadrant in which A *is to be taken is known*,

$$\left.\begin{aligned} \tan\varphi &= \tan B\cos a \quad (\varphi < 180^\circ) \\ \tan A\cos b &= -\tan(C+\varphi) \\ \tan A\sin b &= -\frac{\sin\varphi\tan a}{\cos(C+\varphi)} \end{aligned}\right\} \qquad (10)$$

When A *and* B *are both less than* 180°;

$$\left.\begin{aligned} m\sin\varphi &= \cos a \qquad (m \text{ positive}) \\ m\cos\varphi &= \cot B \\ n\sin b &= \sin\varphi\tan a \; (n \text{ positive}) \\ n\cos b &= \sin(C+\varphi) \\ \cot A &= -\cot(C+\varphi)\cos b \end{aligned}\right\} \qquad (11)$$

Check. With (10) or (11) we may employ $\sin A \sin b = \sin B \sin a$ and with any of the solutions (7), (8), (9), (10), (11), the check

$$\frac{\sin (C + \varphi)}{\sin \varphi} = \frac{\sin A \cos b}{\sin B \cos a} = \frac{\tan a}{\tan b}$$

4. *Given* B, C, *and* a, *to find* b *and* c. We employ GAUSS's equations arranged as follows: —

$$\left.\begin{array}{l} \sin \frac{1}{2} A \sin \frac{1}{2} (b + c) = \sin \frac{1}{2} a \cos \frac{1}{2} (B - C) \\ \sin \frac{1}{2} A \cos \frac{1}{2} (b + c) = \cos \frac{1}{2} a \cos \frac{1}{2} (B + C) \\ \cos \frac{1}{2} A \sin \frac{1}{2} (b - b) = \sin \frac{1}{2} a \sin \frac{1}{2} (B - C) \\ \cos \frac{1}{2} A \cos \frac{1}{2} (b - c) = \cos \frac{1}{2} a \sin \frac{1}{2} (B + C) \end{array}\right\} \quad (12)$$

which present no ambiguity when the sign of $\cos \frac{1}{2} A$ is given; that is, *when the sign of* sin A *is given*, observing that $\sin \frac{1}{2} A$ is always positive and $\cos \frac{1}{2} A$ has the same sign as $\sin A$.

As before, when these equations lead to values of b or c greater than 360°, the true values are to be found by subtracting 360°.

5. *Given* a, b, *and* A, *to find* B, C, *and* c. The general relations between the given and required parts are

$$\left.\begin{array}{r} \sin a \sin B = \sin b \sin A \\ -\cos C \cos A + \sin C \sin A \cos b = \cos B \\ \sin C \cos A + \cos C \sin A \cos b = \sin B \cos a \\ \cos c \cos b + \sin c \sin b \cos A = \cos a \\ \sin c \cos b - \cos c \sin b \cos A = \sin a \cos B \end{array}\right\} \quad (13)$$

The first equation determines B *when the sign of* cos B *is given;* and B being known, the remaining equations will fully determine C and c. Thus we find first

$$\sin B = \frac{\sin b \sin A}{\sin a} \quad (14)$$

Then from the second and third of (**13**)

$$\left.\begin{array}{ll} K \sin \varphi = \cos A & (K \text{ positive}) \\ K \cos \varphi = \sin A \cos b & \\ K \sin \varphi' = \cos B & \\ K \cos \varphi' = \sin B \cos a & \\ C = \varphi + \varphi' & \end{array}\right\} \quad (15)$$

From the fourth and fifth, [1]

$$\left.\begin{array}{ll} K \sin \theta = \sin b \cos A & (K \text{ positive}) \\ K \cos \theta = \cos b & \\ K \sin \theta' = \sin a \cos B & \\ K \cos \theta' = \cos a & \\ c = \theta + \theta' & \end{array}\right\} \quad (16)$$

In these solutions it may happen that $\varphi + \varphi'$, or $\theta + \theta'$, exceeds 360°, in which case $C = \varphi + \varphi' - 360°$, or $c = \theta + \theta' - 360°$.

Checks. One of the following may be employed when either C or c has alone been computed: —

$$\frac{\sin \varphi}{\sin \varphi'} = \frac{\cos A}{\cos B}, \qquad \frac{\cos \varphi}{\cos \varphi'} = \frac{\tan a}{\tan b}$$

$$\frac{\sin \theta}{\sin \theta'} = \frac{\tan B}{\tan A} \qquad \frac{\cos \theta}{\cos \theta'} = \frac{\cos b}{\cos a}$$

[1] The propriety of employing the same factor K in both (**15**) and (**16**) will be seen by comparing the values of K deduced from the two groups. We find in both cases $K^2 = 1 - \sin^2 A \sin^2 b$.

When both C and c have been computed, the obvious check is

$$\frac{\sin C}{\sin c} = \frac{\sin A}{\sin a}$$

5. *Given* a, b, *and* A, *to find* C *and* c *without finding* B. Observing that K is positive in the preceding article we deduce the following forms and conditions, by eliminating B;

$$\left.\begin{array}{ll} K \sin \varphi = \cos A & (K \text{ positive}) \\ K \cos \varphi = \sin A \cos b & \\ \cos \varphi' = \cos \varphi \cot a \tan b & (\varphi' \text{ less} \\ \text{than } 180°, \text{ with the same sign as } \cos B.) & \\ C = \varphi + \varphi' & \end{array}\right\} \quad (17)$$

$$\left.\begin{array}{ll} K \sin \theta = \sin b \cos A & (K \text{ positive}) \\ K \cos \theta = \cos b & \\ \cos \theta' = \dfrac{\cos \theta \cos a}{\cos b} & (\theta' \text{ less} \\ \text{than } 180°, \text{ with the same sign as } \sin a \cos B.) & \end{array}\right\} \quad (18)$$

Check.

$$\frac{\sin C}{\sin c} = \frac{\sin A}{\sin a}$$

In these solutions, when $\varphi + \varphi'$ and $\theta + \theta'$ exceed 360°, we must take $C = \varphi + \varphi' - 360°$, $c = \theta + \theta' - 360°$; and when they are negative we must take $C = \varphi + \varphi' + 360°$, $c = \theta + \theta' + 360°$.

6. *Given* A, B, *and* a, *to find* b, c, *and* C. We find b by the formula

$$\sin b = \frac{\sin B \sin a}{\sin A}$$

which determines b *when the sign of* cos b *is given.* The remainder of the solution is by (**15**) and (**16**).

7. *Given* A, B, *and* a, *to find* C *and* c *without finding* b. We may eliminate b from (**15**) and (**16**) in their present form, but the conditions for determining the auxiliary angles will not be so simple as in the following method. Let φ and φ' in (**15**) be exchanged for $\varphi' - 90°$ and $\varphi + 90°$ respectively; then, after eliminating b, we find

$$\left.\begin{array}{ll} K \sin \varphi = -\sin B \cos a & (K \text{ positive}) \\ K \cos \varphi = \cos B & \\ \cos \varphi' = -\dfrac{\cos \varphi \cos A}{\cos B} & (\varphi' \text{ less} \\ \text{than } 180°, \text{ with the sign of } \sin A \cos b.) & \\ C = \varphi + \varphi' & \end{array}\right\} \quad (19)$$

In a similar manner from (**16**) we find

$$\left.\begin{array}{ll} K \sin \theta = -\cos a & (K \text{ positive}) \\ K \cos \theta = \sin a \cos B & \\ \cos \theta' = -\cos \theta \cot A \tan B & (\theta' \text{ less} \\ \text{than } 180°, \text{ with the sign of } \cos b.) & \\ c = \theta + \theta' & \end{array}\right\} \quad (20)$$

Check.

$$\frac{\sin C}{\sin c} = \frac{\sin A}{\sin a}$$

In these formulas, as before, when $\varphi + \varphi'$ and $\theta + \theta'$ exceed

360°, we take $C = \varphi + \varphi' - 360°$, $c = \theta + \theta' - 360°$; and when they are negative we take $C = \varphi + \varphi' + 360°$, $c = \theta + \theta' + 360°$.

8. *Given* a, b, *and* c, *to find* A, B, *or* C. The formula

$$\cos A = \frac{\cos a - \cos b \cos c}{\sin b \sin c} \qquad (21)$$

determines *A when the sign of* sin A *is given*; or *when the sign of either* sin A, sin B, *or* sin C *is given*, since, when the sign of any one of these functions is known, those of the other two may be discovered by an inspection of the equation

$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c}$$

The usual formulas for $\frac{1}{2} A$, cos $\frac{1}{2} A$, tan $\frac{1}{2} A$, derived from (**21**), may be employed, and the ambiguity removed, by the same conditions.

Check. Compute two of the functions sin $\frac{1}{2} A$, cos $\frac{1}{2} A$, tan $\frac{1}{2} A$; or one of them in connection with (**21**).

9. *Given* A, B, *and* C, *to find* a, b, *or* c. The formula

$$\cos a = \frac{\cos A + \cos B \cos C}{\sin B \sin C} \qquad (22)$$

determines *a when the sign of* sin a *is given*; or *when the sign of either* sin a, sin b *or* sin c *is given*, since when the sign of any one of these functions is known, those of the other two may be discovered by an inspection of the equation

$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c}$$

The usual formulas for sin $\frac{1}{2} a$, cos $\frac{1}{2} a$, tan $\frac{1}{2} a$, may be employed and the ambiguity removed, by the same conditions.

Check. Compute two of the functions sin $\frac{1}{2} a$, cos $\frac{1}{2} a$, tan $\frac{1}{2} a$; or one of them in connection with (**22**).

10. From the preceding sketch it appears that for the determinate solution of a spherical triangle generally considered, there are required *four* data; namely, the numerical values of three of the six parts composing the triangle, and the algebraic sign of one of the functions of a required part. To recapitulate, the triangle is fully determined by the following data: —

1. b, c, A; and the sign of either sin a, sin B, cos B, sin C, or cos C.
2. B, C, a; and the sign of either sin A, sin b, cos b, sin c, or cos c.
3. a, b, A; and the sign of cos B.
4. A, B, a; and the sign of cos b.
5. a, b, c; and the sign of either sin A, sin B, or sin C.
6. A, B, C; and the sign of either sin a, sin b, or sin c.

FROM A LETTER OF S. C. WALKER, ESQ., TO THE EDITOR.

Washington, March 18, 1850.

You have, in my Smithsonian Ephemeris of Neptune, the comparison of Elements II. with the normal places deduced from observation, up to 1848. I have since increased the number of comparisons. The case now stands: —

Observation — Ephemeris.

1848.	$\Delta\alpha$	No. Obs.	$\Delta\delta$	No. Obs.
Aug. 24	−0″.64	99	−0″.10	99
Nov. 10	−0″.63	44	−0″.46	44

The following is the comparison for 1849. The normal places are derived chiefly from the Altona and Hamburg observations, though a few others have been used.

Observation — Ephemeris.

1849.	$\Delta\alpha$	No. Obs.	$\Delta\delta$	No. Obs.
Aug. 26	−0″.53	22	−0″.55	17
Nov. 13	+0″.29	28	−0″.87	30

You see from this, that no change can be made in the Elements for the Ephemeris for 1850, which I hope to have ready for publication in April.

SEARS C. WALKER.

LETTER FROM DR. A. C. PETERSEN, OF THE ALTONA OBSERVATORY, TO THE EDITOR.

[Translation.]

Altona, February 22, 1850.

Professor Schumacher, who is not well, has requested me to transmit to you the following notices, sent him by Mr. J. R. Hind.

1. Position of a scarlet star between Orion and Eridanus: —

$$\alpha = 4^{h.}\ 52^{m.}\ 45^{s.} \qquad \delta = -15°\ 2'$$

2. Dr. Lamont has twice observed the planet Neptune as a fixed star, in his Zones; — the first time, Oct. 25, 1845, when he estimated it as of the ninth magnitude, he observed its transit over the middle thread at $21^{h.}\ 42^{m.}\ 43^{s.}.1$; the second time was Sept. 7, 1846, when it crossed the second thread at $21^{h.}\ 54^{m.}\ 24^{s.}.9$, and was entered as of the eighth magnitude. Mr. Hind finds from these observations — after determining the instrumental corrections from some of the brighter stars in each zone, by the aid of the Greenwich and Edinburgh Catalogues — the following apparent places of the planet: —

Date.	M. T. Greenwich. h. m. s	α ♆ h m. s	δ ♆ ° ′ ″
1845, Oct. 25	6 40 15	21 42 42.48	−14 14 23.0
1846, Sept. 7	10 1 57	21 54 44.51	−13 16 21.8

3. Mr. Hind has discovered, January, 1850, a new nebula, which he describes as follows: —

1850, Mean R. A. = $12^{h}\ 0^{m}\ 33^{s}.16$ N. P. D. = $23° 59' 30''.1$

It is tolerably bright, but small.

By this opportunity I must announce to you, that I have also discovered a new and exceedingly faint nebula, which I took at first for a comet. Its position for 1850 is about

$\alpha = 6^{h}\ 4^{m}\ 14^{s}$ $\delta = +12° 40'$.

I have unfortunately not the time to describe it more precisely at present; and, indeed, a nearer description would hardly have any special interest for you.

A. C. PETERSEN.

OBSERVATIONS OF ASTRÆA,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

BY MR. JAMES FERGUSON.

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Obs.	Star of Comparison.	⚓ — * $\Delta\alpha$	⚓ — * $\Delta\delta$	⚓'s apparent α	⚓'s apparent δ	
1849	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
Oct. 14	10 8 22.2	2	781, Weisse C.	—3 34.29	—13 6.71	3 37 2.47	+11 1 27.45	
	10 50 26.1	2	*b*	—1 34.04	—10 47.17	37 1.56	11 1 15.70	
15	9 45 36.4	4	781, Weisse C.	—4 2.46	—17 19.40	36 34.35	10 57 13.68	Misty.
Nov. 2	10 48 6.4	6	*g*	+1 36.51	+ 0 43.32	23 45.90	9 33 7.74	Misty.
		6	*h*	+0 8.69	+ 0 1.74	23 45.29	33 12.06	
	11 4 54.6	4	*e*	+2 25.77	+ 7 0.78	23 44.67	33 8.49	
		4	*f*	+1 52.22	+ 6 38.02	23 44.68	33 8.16	
4	10 2 53.2	8	*e*	+0 40.69	— 2 6.17	21 59.60	24 1.57	Misty.
		8	*f*	+0 7.21	— 2 28.41	21 59.69	24 1.83	
	10 31 0.1	2	*g*	—0 11.48	— 8 28.91	21 57.95	23 55.57	
	11 26 11.2	1	*e*	+0 37.40	— 2 18.25	21 56.31	23 49.39	
		1	*f*	+0 4.00	— 2 44.87	21 56.48	23 45.20	
5	10 34 8.1	4	*e*	—0 15.24	— 6 43.43	21 3.69	19 24.02	Misty.
	10 44 12.7	2	*f*	—0 48.50	— 7 3.14	21 3.99	19 26.85	
		2	*g*	—1 4.90	—13 0.64	21 4.53	19 23.76	
6	10 7 13.5	7	*e*	—1 9.64	—11 11.44	20 9.27	14 55.95	Misty.
	10 31 49.2	5	1068, B. A. C.	+1 5.87	+ 2 39.74	20 9.14	14 54.74	
	12 17 59.5	1	"	+1 1.20	+ 2 16.96	20 4.48	14 32.73	
7	8 51 13.7	2	"	+0 13.65	— 1 40.27	19 16.57	10 35.49	Planet scarcely visible.
	9 21 14.1	8	"	+0 12.23	— 1 44.23	19 15.16	9 10 31.53	
10	9 32 33.3	2	299, Weisse C.	—0 42.59	—11 55.10	3 16 24.17	+ 8 57 26.61	Clouds, and high wind.

(*Continued on the next page.*)

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A volume will consist of twenty-four numbers, with a table of contents and alphabetical index. The price of subscription is $ 5.00, payable in advance, which may be sent either to the Editor, to the Publishers, Messrs. JAMES MUNROE & Co., Cambridge and Boston, or, in England, to Mr. JOHN CHAPMAN, London. Subscribers in France and Germany are requested to state in what way they prefer to have the Journal sent them.

THE

ASTRONOMICAL JOURNAL.

No. 7.

VOL. I. CAMBRIDGE, APRIL 20, 1850. NO. 7.

OBSERVATIONS OF ASTRÆA,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

(*Continued from page* 48.)

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Obs.	Star of Comparison.	⚴ — * $\varDelta\alpha$	$\varDelta\delta$	⚴'s apparent α	δ	
1849.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
Nov. 10	9 35 43.8	4	1068, B. A. C.	—2 39.67	—14 45.71	3 16 23.26	+8 57 29.95	
12	11 48 34.5	5	f'	+0 54.34	— 0 16.03	14 23.71	48 49.29	Fine night.
		5	h'	—0 0.34	— 0 18.78	14 23.64	48 49.29	
13	9 5 57.8	5	i'	+1 1.74	+15 47.16	13 32.05	45 6.69	
		5	f'	+0 2.95	— 3 55.22	13 32.31	45 10.07	Fine night. Planet like star of 9th magnitude.
		5	g'	—0 13.16	+ 3 45.14	13 32.12	45 9.40	
		4	1057, B. A. C.	—3 13.12	+15 21.31	13 31.99	45 7.97	
13	11 19 56.1	1	i'	—0 56.31	+15 32.19	13 26.62	44 51.94	
		1	g'	—0 18.90	— 3 24.04	13 27.37	44 48.32	
		1	1057, B. A. C.	—3 18.30	+15 3.87	13 26.81	44 50.30	
24	10 4 43.4	5	975, B. A. C.	+2 30.86	+14 40.77	3 8.34	7 54.47	
		5	m	+1 43.59	+ 1 50.99	3 8.36	7 57.04	
		5	35, Weisse C.	+0 5.66	— 1 1.38	3 8.63	7 55.58	
	10 16 8.0	3	62, Weisse C.	—1 24.62	+ 6 32.97	3 8.59	7 59.94	
26	10 9 59.2	2	35, Weisse C.	—1 39.55	— 6 6.86	1 23.42	2 50.10	
		2	62, Weisse C.	—3 9.80	+ 1 26.87	1 23.41	2 53.53	
	10 22 12.1	8	975, B. A. C.	+0 45.00	+ 9 38.85	1 22.49	2 52.46	
27	8 46 43.8	10	"	—1 2.17	+ 7 30.95	3 0 35.32	8 0 44.58	
Dec. 6	8 24 32.1	1	"	—6 51.30	— 5 36.64	2 53 46.20	7 47 36.45	Very high wind.
	8 36 40.7	4	967, Weisse C.	—1 2.24	— 5 2.92	53 45.57	47 34.12	
	8 54 2.5	7	"	—1 4.44	— 5 5.97	53 43.36	47 30.97	
11	9 8 17.0	2	905, B. A. C.	+2 32.26	+ 0 3.50	50 45.35	46 29.54	Misty.
12	6 42 22.6	2	"	+2 1.91	+ 0 7.84	50 15.00	46 33.82	
	9 5 24.6	3	967, Weisse C.	—4 33.96	— 6 3.89	50 13.84	46 32.69	
17	7 22 51.4	7	905, B. A. C.	—0 7.88	+ 4 15.50	48 5.20	50 41.20	
	8 1 22.6	2	"	—0 8.58	+ 4 14.53	48 4.49	50 40.23	Flying clouds. Observations interrupted.
	9 0 38.5	2	"	—0 9.22	+ 4 20.19	48 3.88	7 50 45.77	
24	7 49 17.4	3	929, B. A. C.	—5 24.60	—14 37.49	46 16.24	8 3 40.23	Clouds.
27	11 28 36.7	4	"	—5 45.13	— 6 16.53	45 56.73	12 6.35	
31	7 26 49.6	3	"	—5 42.07	+ 6 21.17	2 45 59.05	+8 24 38.19	Windy.

Adopted Mean Places, for 1850.0, of Comparison-Stars.

*	Mag.	α	Ann. Prec.	δ	Ann. Prec.	Authority.	No. of Obs.
		h m s	s	° ′ ″	″		
781, Weisse C.	8.9	3 40 36.98	+3.289	+11 14 38.30	+11.457	Weisse's Catalogue.	
b	8	3 38 35.78	3.286	11 12 8.10	11.603	W. Equatorial, from 781, Weisse C.	5
e	9	3 21 18.72	3.241	9 26 12.704	12.802	" from 1068, B. A. C.	5
f	9	3 21 52.29	3.241	9 26 35.251	12.765	" from *e*.	12
g	9	3 22 9.23	3.243	9 32 29.66	12.755	" from *e*.	7
h	9.10	3 23 36.44	3.245	9 33 15.36	12.647	" from *e*.	4
1068, B. A. C.	4	3 19 2.697	3.236	9 12 20.958	12.958	Rümker, *Astr. Nachr.*, No. 703.	
299, Weisse C.	9	3 17 6.49	3.234	9 9 26.95	13.084	Weisse's Catalogue.	
f′	9	3 13 29.10	3.226	8 49 10.62	13.322	W. Equatorial, from 1057, B. A. C.	4
g′	8.9	3 13 45.01	3.224	8 41 29.69	13.305	" from 1057, B. A. C.	5
h′	10	3 14 23.71	3.226	8 49 13.36	13.263	" from *f*.	5
i′	8	3 12 30.03	3.219	8 29 5.08	13.387	" from 1057, B. A. C.	5
1057, B. A. C.	4	3 16 41.83	3.222	8 29 52.00	13.106	Brit. Assoc. Catalogue.	
975, B. A. C.	7	3 0 37.15	3.202	7 53 19.30	14.142	"	
m	9.10	3 1 24.41	3.206	8 6 11.82	14.094	W. Equatorial, from 975, B. A. C.	5
35, Weisse C.	9	3 3 2.62	3.207	8 9 2 56	13.992	Weisse's Catalogue.	
62, Weisse C.	9	3 4 32.86	3.205	8 1 32.60	13.897	"	
967, Weisse C.	8	2 51 47.46	3.198	7 52 43.00	14.499	"	
905, B. A. C.	6.7	2 48 12.79	3.193	7 46 32.30	14.892	Brit. Assoc. Catalogue.	
929, B. A. C.	6.7	2 51 41.03	+3.201	+8 18 24.70	+14.686	"	

NOTE FROM PROFESSOR BACHE TO THE EDITOR.

Dear Sir, — *Washington, March* 9, 1850.

By authority from the Honorable Secretary of the Treasury, I inclose you, for the *Astronomical Journal*, the abstract of a report of Sears C. Walker, Esq., one of the assistants of the United States Coast Survey, on the recent telegraph operations for longitude, including the experiments for the measurement of the time of propagation of the hydro-galvanic current in the telegraph lines of the United States.

A. D. BACHE,
Superintendent U. S. Coast Survey.

ON THE RECENT TELEGRAPH OPERATIONS OF THE U. S. COAST SURVEY.

By SEARS C. WALKER,
ASSISTANT U. S. COAST SURVEY.

With a Copperplate.

To PROFESSOR A. D. BACHE, LL. D.,
Superintendent United States Coast Survey.

Dear Sir, — In compliance with your instructions, I beg to submit an abstract of my report of January 31, on the experiments of the Coast Survey for determining the small correction of the local automatic registers of the transits of stars, used for determining the longitudes of the stations.

The experiments of Mr. Wheatstone, made with apparatus devised and executed by Mr. Saxton, give the velocity of propagation of the waves of frictional electricity, similar to that of radiant light or heat. The smallness of the tension of the hydro-galvanic current had induced Professor Henry, in 1846, and Professor Lovering, in 1847, to express to me their opinion, that its velocity of propagation would be much smaller than that of light, heat, and frictional electricity, and that it would, perhaps, be measurable by the processes then in use in the telegraph operations of the Coast Survey. In 1846 – 48, the experiments, though carefully examined for this purpose, gave no indications of a measure of this velocity. The introduction of the automatic circuit-breakers, for graduating the registers, gave hopes of better success, and the operations of the 23d of January, 1849, for determining by the new process the longitudes of Cambridge, New York, and Philadelphia, indicated discrepancies in the local readings of the dates of transits of stars, attributable only to the hypothesis of a sensible value for the propagation of the hydro-galvanic waves. This interpretation of the phenomenon was suggested in my report of February 21, 1849, of which an abstract was published in the Proceedings of

the American Philosophical Society for March 16, 1849. A reprint of this abstract may be found in the six hundred and seventy-sixth number of the *Astronomische Nachrichten* of Professor Schumacher. A critical notice of this article from the pen of Professor Steinheil of the Royal Academy of Bavaria, was published in the six hundred and seventy-ninth number of the above-mentioned journal, which has been translated and published with comments by Dr. B. A. Gould, Jr. Mr. Steinheil, whilst giving his weighty sanction to the mode of conducting the experiment, and interpreting its results, expresses a wish for a further accumulation of data, with a view to increase of precision in the measurement, and invites the attention of the Germans to this subject. I have not yet heard whether these experiments have been repeated in Europe; but I was satisfied from the inspection of the work of January 23, 1849, that the laws which govern these local discrepancies of the readings must be studied by the astronomer proposing to determine longitudes by the telegraph, with as much care as he does those of the aberration of light. Accordingly, with your approbation, on the nights of the 31st of October and the 5th and 21st of November, the arrangements were made, both with reference to the determination of the difference of longitude between Seaton Station and the Cincinnati Observatory under Professor Mitchel, and to the measurement of *wave-time.* The former element, the longitude of Cincinnati, is an important item in the Coast Survey operations, as affording the readiest means of connecting Washington and New Orleans.

My report of January 31 is confined to the discussion of the latter operation, namely, the measurement of *wave-time* on the line between Washington and Cincinnati. The first part of these experiments consisted in the double graduation of the registering fillets by the Saxton circuit-breaking clock at Seaton Station, and by that of Professor Mitchel at Cincinnati, for a period of an hour or more. The second part consisted in the imprinting of the signal pauses or electrotomes by the operator at the Cumberland office, for a term of twenty minutes, while both clocks were gradnating the fillets at all the stations. The third part consisted in the repetition of the same experiment by the operator at Wheeling. The last two portions of this night's work have, by your direction, been referred for discussion to Mr. R. Culmann of the Royal Bavarian Engineers, now on a professional tour through this country.

Before presenting the results of the first portion, namely, the direct comparison of the two clock-scales on the respective registering fillets of paper, it is proper to submit a brief statement of the analytical theory of telegraph operations, which has been given in my successive reports since 1846.

The mode of effecting the automatic register of the dates of events, by means of the galvanic current, has been described at length in my report of December 15, 1848, and in my subsequent report read to the American Association for the Advancement of Science, in August, 1849. The drawings of Figures 1 and 2, in the accompanying plate, exhibit the peculiarities of the armature movements, and the dimensions of the telegraph line. Figure 3 shows a specimen of a graduated paper fillet, with its automatic *pauses* and *lines*, on which an arbitrary pause FG has been inserted by an electrotome made at a signal station. I will now proceed to the formation of the equations of condition for computing the effect of wave-time on the local readings of an arbitrary signal or pause, imprinted on an automatic clock-scale, as exhibited in the local registers. For this purpose we have, —

AB, CD, &c. $=$ the clock lines or times of continuation of the active galvanic currents (*electropœas*) on a continuous circuit. These may be compared to *syllables* in the case of propagation of *waves* of *sound* in the air. The intervening pauses are analogous to the intervals of *silence* between *sounds*.

BC, CD, &c. $=$ the clock-pauses (*electrotomes*), or interruptions of the galvanic current.

$FG =$ the *signal* pause or electrotome, made by the operator, by tapping on the *break-circuit* key.

$DF =$ the *electrotome* scale-reading of the beginning, F, of the signal pause.

$EG =$ the *electropœa* scale-reading of the end, G, of the same signal pause.

$DH =$ the measure of the reading of a second on the *electrotome* scale.

$EI =$ the same for the *electropœa* scale.

$b =$ the equivalent of DF in time $= \frac{DF}{DH}$.

$m =$ " " " EG " $= \frac{EG}{EI}$.

$l = \frac{EF}{DH}$.

$L = \frac{GH}{EI}$.

l_0, $L_0 =$ the absolute values of l and L.

a, $a_1 =$ the miles traversed respectively by the clock- and signal-waves in going to the receiving station.

$x =$ the time of propagation of the hydro-galvanic wave through one mile of a, or a_1.

α, $\alpha_1 =$ the time of decrease or waning of the magnetic force of attraction, after the first electrotome wave reaches the receiving magnet, before the force falls below that of the spiral spring (increased by friction), which, by drawing back the armature, severs the metallic connection of the local circuit, for the *clock-* and *signal-*electrotomes. Professor Henry's researches have shown that these quantities α and α_1 are increased by the action of the secondary current, which retards this waning the more, the greater the length of the telegraph line.

β, $\beta_1 =$ the times of induction of magnetism after the electropœa wave reaches the receiving magnet, before the attraction of the magnet upon the armature severs it from contact with the outer brace, for the *clock-* and *signal-*waves respectively. These quantities are also increased by the action of the secondary current.

γ, $\gamma_1 =$ times of the armature traversing the *pass* inwards,

after motion commences posterior to the clock and signal electropœas.

δ, δ_1 = the outward *pass times* for the clock and signal electrotomes.*

Then we have for the conditional equation from the clock and signal electrotomes and electropœas, respectively, the expressions,

$$\text{I.}\quad \begin{aligned} 0 &= (a_1 - a)\,x + (\alpha_1 - \alpha) + (b_0 - b) \\ 0 &= (a_1 - a)\,x + (\beta_1 - \beta) + (\gamma_1 - \gamma) + (m_0 - m). \end{aligned}$$

Also for any other receiving station, marking the letters with an accent above,

$$\text{II.}\quad \begin{aligned} 0 &= (a_1' - a')\,x + (\alpha_1' - \alpha') + (b_0 - b') \\ 0 &= (a_1' - a')\,x + (\beta_1' - \beta') + (\gamma_1' - \gamma') + (m_0 - m'). \end{aligned}$$

Subtracting the equations (II.) from (I.) to eliminate b_0 and m_0,

$$\text{III.}\quad \begin{aligned} 0 &= \left[(a_1 - a) - (a_1' - a')\right]x + \left[(\alpha_1 - \alpha) - (\alpha_1' - \alpha')\right] + (b' - b) \\ 0 &= \left[(a_1 - a) - (a_1' - a')\right]x + \left[(\beta_1 - \beta) - (\beta_1' - \beta')\right] + (\gamma_1 - \gamma) - (\gamma_1' - \gamma')\big] + m' - m). \end{aligned}$$

And by the mean of expressions (III.),

$$\text{IV.}\quad 0 = \left[(a_1 - a) - (a_1' - a')\right]x + \tfrac{1}{2}\left[(\alpha_1 - \alpha) - (\alpha_1' - \alpha')\right] + \tfrac{1}{2}\left[(\beta_1 - \beta) - (\beta_1' - \beta')\right] + \tfrac{1}{2}\left[(\gamma_1 - \gamma) - (\gamma_1 - \gamma)\right] + \tfrac{1}{2}\left[(b' - b) + (m' - m)\right].$$

From (III.) and (IV.), we derive the equations of condition,

$$\text{V.}\quad \begin{aligned} 0 &= a\,x + y + B \\ 0 &= a\,x + z + u + M \\ 0 &= a\,x + \tfrac{1}{2}(y + z + u) + \tfrac{1}{2}(B + M) \end{aligned}$$

where

$$\text{VI.}\quad \begin{aligned} a &= \left[(a_1 - a) - (a_1' - a')\right] \\ y &= \left[(\alpha_1 - \alpha) - (\alpha_1' - \alpha)\right] \\ z &= \left[(\beta_1 - \beta) - (\beta_1' - \beta)\right] \\ u &= \left[(\gamma_1 - \gamma) - (\gamma_1' - \gamma)\right] \\ B &= b' - b \\ M &= m' - m \\ \tfrac{1}{2}(B + M) &= \tfrac{1}{2}\left[(b' - b) + (m' - m)\right] \\ &= \tfrac{1}{2}\left[(L_1 - L_1') - (l - l')\right].\dagger \end{aligned}$$

The import of the terms y, z, and u may be gathered from the drawing of Fig. 1. That of a, from the tracing of the telegraph line from Washington to Cincinnati, via Wheeling, in Fig. 2. The experiments were not so arranged as to present a full discrimination between the resistance of the wire, the ground, and the batteries. This must be the subject of future experiments.

In the accompanying plate, Fig. 1, —

A, B, and C are stations on the main line; A is that of the receiving magnet M. B and C are more remote successively.

E is the main-line battery.

M is the receiving magnet.

F is the armature.

O is the outward limit of armature distance.

I is the inner, preventing absolute contact of F and M.

$O\ I$ is the *pass*, so called, between the inner surfaces of O and I. Both have adjusting screws for position.

S is the spiral spring.

K, the key for its adjustment for tension.

$I\ D\ F$ is the local circuit.

D is the local battery.

It may be seen from the drawing, that when the armature-beam F is in contact with I, the local circuit is complete. But the departure of F through an indefinitely small space breaks the metallic contact with I, and thus breaks the local circuit. When the adjustments are all properly made, F, on leaving I, departs through the *pass* to contact with O, and there remains, till the circuit is restored on the main line, when M, again becoming a magnet, attracts F, and draws it back from O, through the *pass* again, to contact with I, restoring thereby the local circuit.

This is called the *make-make* arrangement, or $F\ I$ connection.

The I end of the local circuit may be removed to O, and giving the *make-break* arrangement, or the $F\ O$ connection.*

Let us now suppose that the adjustments of position of O and I, and of tension of S, are made to suit the intensity of the current from the battery, E, acting on the magnet, at the receiving station A, so that an electrotome at A causes the armature to depart through the pass to I, and an electropœa, or restoration of circuit, again draws F through the pass back to contact with I.

Now, whenever the meteorological condition of the atmosphere is such, that a friction-electrical machine would work well, the line, if properly insulated, also works well. Such a state of the atmosphere occurs in this country, when a northwest wind prevails, with cool weather or frost, after the clearing up from a northeasterly storm, or from a south or south-

* The quantities analogous to α, β, γ, and δ for the local magnet and register are omitted, because they are the same for the clock and signal electrotomes and electropœas, and their difference is null.

† The second form is more easily measured than the first. It does not afford the same facilities for the separate measurement of B and M.

* This kind of connection has recently been used by Mr. J. J. Speed, of Detroit, in his ingenious invention of the universal relay apparatus.

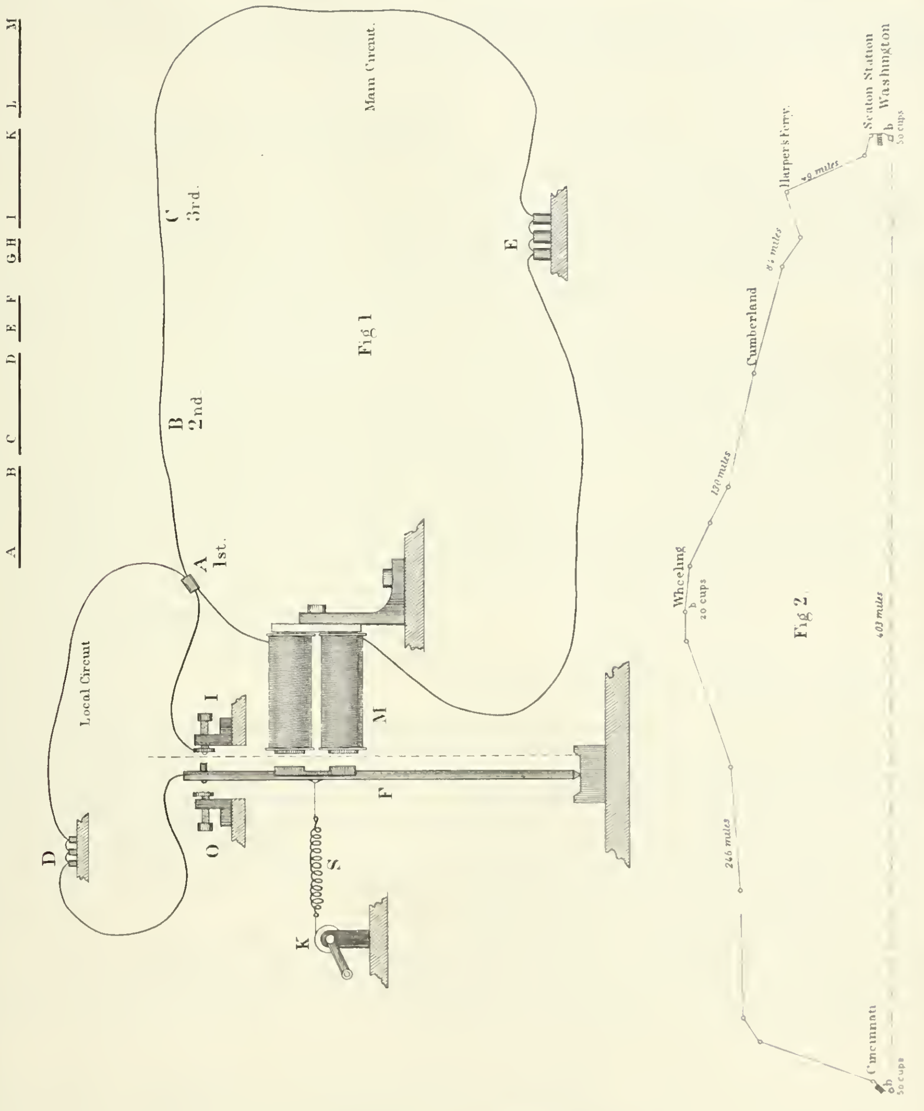
Fig. 3.
A
B
C
D
E
F
G H
I
K
L
M
Fig 1
Main Circuit.
Local Circuit
A
1st.
B
2nd.
C
3rd.
D
E
I
O
S
K
F
M
Fig 2.
Cincinnati
50 cups
246 miles
Wheeling
20 cups
130 miles
Cumberland
84 miles
Harper's Ferry.
49 miles
Seaton Station
Washington
50 cups
403 miles

westerly rain, or snow. Such have been the nights of our experiments for wave-time.

In this case the magnet being adjusted for A's *dots*, as it is called, B's and C's dots are well received by A, and so on, for all the other stations, whether considered as *dotting* or *receiving* stations.

On bad working nights, a new adjustment is required for the receiving-magnet appurtenances for each change of the dotting station. Such nights are unfit for the experiment, and have not been used for the purpose. They are unsatisfactory, even for the exchange of star-signals.

The fact that each receiving magnet, on the 31st of October and 21st of November, could receive, in the same second of time, the dots at all the stations from Washington to Cincinnati, is conclusive in favor of the good insulation of the line, and of the good meteorological condition of the atmosphere. Still, as no insulation is perfect, and as no meteorological state of the atmosphere is perfect, let us conceive that there was at each station a slight change of residual galvanic action of the current on the magnet, from change of place of the dotting station. This change, we know, both from theory and experience, must be an increase of residual action of the magnet for increase of distance of the dotting station when external to the battery, still, however, varying within the limits suitable for good action of the receiving magnet. When there are several batteries on the line, a dotting station may be external to one, and internal to another. In this case, the ordinary principle in mechanics of the composition of forces may be applied, and the relative effect of the dispersion of the galvanic force by imperfect insulation along the lines traversed by the clock- and signal-waves may be either an increase or diminution of the residual tension, after the electrotome.

Now let us make, —

$W =$ the number of grains that the receiving magnet, M, will lift, when at the inner limit, I, of distance from the poles of the magnet, by the total intensity of the galvanic current from the battery, E, acting at the receiving station.

$W_1 =$ the number of grains of lifting destroyed by the electrotome at the receiving-magnet station.

W_2, W_3, &c.* $=$ the same for the second and third, &c., stations, in the order of distance from the receiving station external to the battery.

R_1, R_2, &c. $=$ the residual weight, $(W - W_1)$, $(W - W_2)$, &c., lifted after the first, second, third, &c., electrotomes.

$Q =$ the number of grains of attraction of the magnet M, for the contact, FI, required to balance the antagonist tension of the spiral spring.

* This decrease of W_n takes place only on the side above the ground external to the battery. On the interior side, each electrotome destroys the total intensity W. In a compound circuit, the same electrotome may be *total* for the effect of one battery, and only *partial* for that of another. In this case, the principle of the composition of forces applies.

$V =$ the friction to be overcome by the movement of the armature F.

The first condition required and actually fulfilled on the 31st of October, in order that the armature, F, should go promptly through the *pass* from I to O, on any *electrotome* at the 1st, 2d, &c., or nth station, is,

$$(Q - V) > R_n.$$

A similar condition, viz.

$$(Q + V) < W'$$

prevails with respect to the *electropœa*, when the armature is at the $F\,O$ contact. In this case, the total intensity, W, for the $F\,I$ contact, becomes W' for the $F\,O$ contact, and overcomes the actual spiral-spring tension, W', and the armature friction V' for the same. This condition was also fulfilled on the 31st of October.

Again, let us call, —

$\varphi\, W_n\, dt =$ the decrement of attractive force (for the $F\,I$ contact) in an element of time for the nth electrotome, which in a finite portion of time, t, destroys the attractive force W_n.

$\varphi'\, R_n'\, dt =$ the increment of attractive force (for the $F\,O$ contact) in an element of time for the nth electropœa, which in a finite portion of time, t', augments the attractive force from R_n' to W_n'.

Then, since the armature F breaks the $F\,I$ connection or local circuit, when the force W has diminished to $W - V$, and breaks the $F\,O$ contact, when the force R_n' has increased to $(Q' + V')$, we have the expressions

$$\alpha_n = \int_{W}^{Q-V} (\varphi\; W_n)\; dt$$
$$\beta_n = \int_{R_n'}^{Q'-V'} (\varphi'\; W_n')\; dt \qquad \text{VII.}$$

where n represents the order of increase of distance of the dotting from the receiving station in the direction above ground external to the battery.

The quantity γ_n for each receiving station must be considered as constant for the period of one or two seconds, during which the experiment lasts, whatever be the locality of the dotting stations; these times of inward vibration of the armature (technically called the inward *pass*) are, like the successive vibrations of a pendulum, *isochronous*. The adjustment of the spiral spring, and outer and inner braces, is the same. The arc of vibration is the same. The spiral-spring tension is the same. The force of attraction $(Q + V')$ at which the vibration commences is the same. The remaining induction of attractive force of the magnet, from $(Q + V')$ to the maximum, takes place during the vibration. We may, therefore, assume that

$$u = \left[(\gamma_1 - \gamma) - (\gamma_1' - \gamma')\right] = 0. \qquad \text{VIII.}$$

Let us make, —

$P =$ the apparent duration of a pause, as read on the graduated fillet of paper.

$P_0 =$ the actual duration of the electrotome, or separation of the metallic closing of the main circuit. Then,

$$P = P_0 - \alpha + (\beta + \gamma)$$
$$m = \left[(P_1 - P) - (P_1' - P')\right] = \left[(z + u) - y\right] = z - y$$
$$\theta = y - z.$$

And,

IX. $$0 = \theta + m.$$

Also let

X. $$\varrho = \left[(R_1 - R) - (R_1' - R')\right]$$
$$\theta = F(\varrho) = \text{function of } \varrho.$$

The character of this function of ϱ depends upon the nature of the integrals of (VII.). It must, I think, be apparent from the inspection of these integrals, that the greater the value of the residual tension R_n after the nth electrotome, the greater that of α_n, or the waning time from a magnetic force of W down to that of $(Q - V)$.

This follows from the general law of dispersion, whether of ponderable or of imponderable fluids, that the rapidity of this dispersion increases with the head of pressure. A similar course of reasoning leads to the conclusion, that while an increase of R_n increases α_n, a consequent increase of R_n' diminishes β_n, because the quantity of magnetism $\left[(Q' - V') - R_n'\right]$ to be induced previous to the commencement of the returning vibration of the armature is diminished by the increase of R_n'. These circumstances authorize the following conclusions with respect to the quantity $\left[\theta = F(\varrho) = y - z\right]$: —

1st. The function $F(\varrho)$ is of such a nature that θ becomes 0, when ϱ becomes 0.

2d. That for a positive value of ϱ, θ is positive for a double reason, viz. that the value of y is positive, and that of z is negative.

3d. That for a negative value of ϱ, θ is negative for a similar double reason.

Let us now suppose, that the selection of the additive and subtractive readings is so made in the conditional equation (V), that the value of x will be positive, when B, or M, or $\frac{1}{2}(B + M)$, is positive, then the quantity $\Sigma\, a\, x$ is *cumulative*, and increases with the number of nights' work, and with the number of stations compared together each night.

On the contrary, the quantities $\Sigma\, y$, $\Sigma\, z$, $\Sigma\, u$, $\Sigma\, \frac{1}{2}(y + z + u)$, instead of being cumulative, tend continually, by the increase of $\Sigma\, a$ (which is their divisor in the conditional equations), to produce the results, —

$$\left.\begin{aligned} \Sigma \frac{x}{a} &= 0 \\ \Sigma \frac{y}{a} &= 0 \\ \Sigma \frac{z}{a} &= 0 \\ \Sigma \tfrac{1}{2}\left(\frac{x}{a} + \frac{y}{a} + \frac{z}{a}\right) &= 0. \end{aligned}\right\} \quad \text{XI.}$$

The conditions of (XI.) are the natural result of the fact that ϱ is an accidental quantity, sometimes positive, and sometimes negative, dependent upon the temporary condition of the line, and its multitude of connections in the offices, and on the instantaneous meteorological circumstances along the line. The rapidity of the convergence of the quantities in (XI.) towards zero increases with the goodness of the line, and with that of the combination of meteorological circumstances.

These theoretical conclusions in (XI.) have not yet been submitted to direct experiment, for want of apparatus for measuring the absolute durations of the *clock* and *signal electrotomes.* The conditional equation of (IX.), which depends upon the relative duration of the measured pauses, (their absolute duration being eliminated,) for the experiments yet made in the Coast Survey operations, very nearly fulfils the condition of compensation involved in the equations of (XII.), viz., that for the separate vanishing of $\Sigma\left(\frac{y}{a}\right)$, $\Sigma\left(\frac{z}{a}\right)$, $\Sigma\left(\frac{u}{a}\right)$, we have also

$$\Sigma\left(\frac{\theta}{a}\right) = \Sigma\left(\frac{x - (z + u)}{a}\right) = \Sigma\left(\frac{y - z}{a}\right) = 0. \qquad \text{XII.}$$

The following table comprises the values of θ and a, as far as they have yet been obtained. The Harper's Ferry and the Wheeling registers have been omitted. The former was adjusted for too long a *pass* of the receiving magnet, thereby introducing an unnecessary source of error. The latter had the *pass* so short, that the readings of the *pauses* were indistinct. In practice, both extremes should be avoided. The retention of these registers, however, would not have made any sensible change in the mean result.

TABLE I.

Collection of the Values of θ from the Coast Survey Experiments.

No. of Cases.	Date. 1849.	Clock Station.	Signal Station.	Station for P.	Station for P'.	$x-(z+u)$ θ	No. of Results. n	Probable Error of Group. e	Relative Miles of Wave Space. a
1	Jan. 23	Phil.	Phil.	Phil.	Wn.	s. —0.014	16	s. ±0.007	0
2	"	"	"	"	Camb.	— .029	11	.007	0
3	"	"	"	"	N. Y.	— .026	11	.007	0
4	"	"	"	Wn.	Camb.	— .007	11	.006	0
5	"	"	"	"	N. Y.	+ .014	11	.008	0
6	"	"	"	N. Y.	Camb.	—0.044	6	±0.011	0

No. of Cases.	Date. 1849.	Clock Station.	Signal Station.	Station for P.	Station for P'.	$x-(z+u)$ θ	No of Results. n	Probable Error of Group. e	Relative Miles of Wave Space a
7	Jan. 23	Phil.	Cd.	Phil.	Wg.	$-0\overset{s}{.}014$	17	$\pm0\overset{s}{.}005$	150
8	"	"	"	"	Camb.	+ .020	17	.006	900
9	"	"	"	"	N. Y.	+ .050	17	.008	400
10	"	"	"	Wn.	Camb.	+ .023	10	.005	750
11	"	"	"	"	N. Y.	+ .033	18	.005	250
12	"	"	"	N. Y.	Camb.	— .027	2	.006	500
13	"	"	N. Y.	Phil.	Wn.	+ .005	7	.010	0
14	"	"	"	"	Camb.	+ .029	6	.010	400
15	"	"	"	"	N. Y.	+ .002	7	.010	400
16	"	"	"	Wn.	Camb.	+ .020	6	.010	400
17	"	"	"	"	N. Y.	— .003	8	.010	400
18	"	"	"	N. Y.	Wn.	+ .050	6	.010	0
19	Oct. 31	Ci.	S. S.	Ci.	S. S.	+ .052	88	.003	806
20	"	"	"	"	Cd.	+ .008	12	.005	161
21	"	S. S.	Cd.	"	S. S.	+ .053	29	.004	421
22	"	"	"	Cd.	Ci.	— .037	36	.004	155
23	"	"	"	"	S. S.	+ .010	34	.004	266
24	"	"	Wg.	Ci.	"	+ .047	12	.005	421
25	"	"	"	"	Cd.	+ .031	12	.005	155
26	"	"	"	Cd.	S. S.	+0.025	17	±0.004	266
For 26 cases					$\Sigma\theta =$	+0.271	427		7201
Indiscriminate mean					$\theta_0 =$	+0.010			
					$\frac{\Sigma\theta}{\Sigma a} =$	$+0\overset{s}{.}000038$			

The initials are,

Wn. for Washington, D. C.
Phil. " Philadelphia, Pa.
N. Y. " New York City.
Camb. " Cambridge, Mass.
S. S. " Seaton Station, D. C.
Cd. " Cumberland, Md.
Wg. " Wheeling, Va.
Ci. " Cincinnati, Ohio.

The results of this table are in conformity with the *accidental* character of the quantities ϱ, y, z, u, and θ. They show that the value of θ is as great for the cases of $a = 0$, as for its maximum value, and that it may, according to circumstances, be positive or negative, while a is positive. It is on this ground that we may assume, with sufficient plausibility, that

$$\Sigma\left(\frac{y+z+u}{2a}\right) = 0, \text{ very nearly.}$$

$$\text{XIII.} \qquad \Sigma X = \Sigma x + \Sigma\left(\frac{y+z+u}{2a}\right) = \Sigma x, \text{ very nearly.}$$

$$n = \tfrac{1}{2}(B+M).$$

Whence the conditional equation for the measurement of the wave-time for one mile of the hydro-galvanic current is very nearly

$$\text{XIV.} \qquad 0 = a\,x + n.$$

The single results are given at length in my report of January 31. From them we derive,

	No. of Measures.	Receiving Stations.
$0 = -806\,x + 0\overset{s}{.}049$	121	(Ci.) — (S. S.)
$-806\,x + 0.054$	218	(Ci.) — (H. F.)
$-645\,x + 0.036$	218	(Ci.) — (Cd.)

$x = +0\overset{s}{.}0000625 =$ wave-time for one mile of space.

$\frac{1}{x} = +16000$ = miles for one second of wave-time.

This value of x is derived from the Seaton-Station signals registered on the Cincinnati clock-scale, October 31, 1849. It confirms the general character of the result for the operations of January 23, 1849, giving a somewhat slower motion of the galvanic waves, viz. sixteen instead of nineteen thousand miles per second.

The remaining experiments, for 31st of October, have by your directions been referred to Mr. R. Culmann, of the Royal Bavarian Engineers, for examination and discussion. The statistics are still too incomplete to warrant a full discussion of the comparative resistance of the ground, the wires, and the batteries. It is desirable to take advantage of the prevailing frosty season, with its favorable meteorological combinations, to repeat the experiment for the measure of this wave-time on a line of greater extent. This proceeding is in fact necessary for the perfection of the art of reducing to a common value the discordant local readings of the printed dates of the transits of stars, in the longitude operations of the Coast Survey.

Yours, truly and respectfully,

SEARS C. WALKER.

Washington, February 1, 1850.

NOTE FROM PROFESSOR HUBBARD TO THE EDITOR.

Observatory, Washington, April 8, 1850.

You remember that we have but four published observations of ENCKE's comet in 1845; viz., one at this observatory, one at Philadelphia, and two at Rome. The observation here was made by Professor COFFIN, July 10. On the 11th, I succeeded in seeing the comet, and compared it by the filar-micrometer, not very satisfactorily, with two other stars, whose places I could not find in the catalogues. Recently, while revising other observations, made about that time, I again took up this, and have been able to reduce it completely. It is as follows: —

	Chron. Times of Transit. h. m. s.	Micrometer Readings. r.	Comet — Star. $\Delta\alpha$ s.	Comet — Star. Δ Mic. r.
Star *a*	22 56 42.0	40.000	+12.0	— 1.592
Comet	56 54.0	38.408		
Star *a*	58 12.0	40.000	+13.0	— 1.717
Comet	58 25.0	38.283		
Star *a*	59 10.0	40.000	+12.0	— 1.778
Comet	22 59 22.0	38.222		
Star *b*	23 0 11.5	52.600	—49.5	—14.378

The correction of the chronometer is $-18^{m.}\ 41^{s.}.19$; the corrections of the comet's place for differential refraction and for parallax are,

	Star *a*. s.	Star *a*. ″	Star *b*. s.	Star *b*. ″
$\Delta\varrho$	+0.012	—0.17	+0.115	—1.52
$\Delta\pi$	—0.310	+3.53	—0.310	+3.53

I have determined the places of the stars by micrometrical comparison with those used by Professor COFFIN, July 10, and which have been since observed with the meridian instruments of the Observatory. The mean places for 1845.0 of my two stars are,

	h. m. s.	° ′ ″
a	5 45 35.14	+29 40 2.58
b	5 46 35.74	29 43 15.79

Hence I have deduced the following: —

1845.	M. T. Washington. h. m. s.	Comet's α. ° ′ ″	Comet's δ. ° ′ ″	Star.
July 11	15 19 9.99	86 27 13.2	+29 39 33.6	*a*
		26 48.2	39 31.1	*b*

ENCKE's ephemeris (*Astr. Nachr.*, No. 534) gives for this time,

$$\alpha = 86°\ 26'\ 47''.2 \qquad \delta = +29°\ 39'\ 44''.8$$

and the mean correction of this ephemeris, deduced from the four hitherto published observations (*Astr. Nachr.*, No. 632), is,

$$\Delta\alpha = +37''.5 \qquad \Delta\delta = -7''.0$$

J. S. HUBBARD.

NOTICE.

THE Editor has been requested by Professor SCHUMACHER to announce, that the King of Denmark cannot, in the present embarrassed situation of that country, confirm the comet-medal established by his predecessors; and that, consequently, no more medals can be awarded for comets discovered since the death of King CHRISTIAN VIII. Professor SCHUMACHER remains, nevertheless, ready to communicate to European Observatories by Circular, as promptly as usual, any information sent him of the discovery of comets.

G.

CORRIGENDA.

Page 44, col. 1, line 17, *for* $K\cos\varphi = m$ *read* $K\cos\varphi = n$.
" 45, " 2, " 7, " Hence, then, " Hence these.
" 45, " 2, " 12, " equation " equations.
" 45, " 2, " —2, *omit* (7).
" 46, " 1, " 1, *for* $\sin(C+\varphi,$ " $\sin(C+\varphi)$.
Page 46, col. 1, line 6, *for* $\frac{1}{2}(b-b)$ *read* $\frac{1}{2}(b-c)$.
" 47, " 1, " 11, " $\frac{1}{2}A$ " $\sin\frac{1}{2}A$.
" 47, " 2, " —18, " +0″.29 " —0″.29.
" 48, " 1, " 5, " 1850 " 1830.

CONTENTS.

THE

ASTRONOMICAL JOURNAL.

No. 8.

VOL. I. CAMBRIDGE, MAY 7, 1850. NO. 8.

ON THE ORBIT OF THE GREAT COMET OF 1843.

By PROFESSOR J. S. HUBBARD.

(*Continued from page* 29.)

§ 5.

The disturbing forces **A**′, **B**′, **C**′, were computed for each fourth day from March 1 to April 18, inclusive, by the formulas of Bessel as given in the treatise on Olbers's Comet.* The constants depending on the relative position of the orbits of the comet and disturbing planets, and the adopted values of the masses, are as follows: —

	n'	i'	P	Log. m'
Mercury	187° 27′ 3″	139° 9′ 18″	270° 24′ 11″	3.31285
Venus	185 53 46	143 17 46	268 16 58	4.39595
Earth	178 30 18	144 22 18	262 49 57	4.44916
Mars	183° 18′ 25″	143° 4′ 58″	265° 4′ 47″	3.57181
Jupiter	183 19 8	144 31 6	265 4 30	6.97969
Saturn	184 49 47	145 11 18	266 51 52	6.45573

As a control, the following formulas, easily derived from the formulas f' (*Comet of* 1807, p. 46), were used, in which the accented letters refer to the disturbing planet, and α, β, γ, are the same with the angles A, B, C, of the *Theoria Motûs*, p. 50: —

$$\rho^2 = r^2 + r'^2 - 2\left[xx' + yy' + zz'\right]$$

$$\mathbf{A}' = \Sigma\left\{\left[xx' + yy' + zz'\right]\frac{m'}{r}\cdot\left(\frac{1}{r'^3} - \frac{1}{\rho^3}\right) + \frac{m'r}{\rho^3}\right\}$$

$$\mathbf{B}' = \Sigma\left\{\left[xx'.\cot(\alpha+\omega+v) + yy'.\cot(\beta+\omega+v) + zz'.\cot(\gamma+\omega+v)\right].\frac{m'}{r}.\left(\frac{1}{r'^3} - \frac{1}{\rho^3}\right)\right\}$$

$$\mathbf{C}' = \Sigma\left\{\left[x'.\sin n.\sin i - y'.\cos n.\sin i + z'.\cos i\right] m'\left(\frac{1}{r'^3} - \frac{1}{\rho^3}\right)\right\}.$$

In the case of Mercury, this control was applied for each date of computation; for the other planets, once or twice only, the rest being checked by differences. The values of the disturbing forces, in units of the tenth decimal, for the several dates, are, —

	A′	B′	C′
March 1	—1089	+13356	+14488
5	2775	11564	36424
9	11041	8354	51320
13	21873	6037	62904
17	34349	5782	72914
21	47328	8131	81965
25	59978	12955	90228
29	71743	19841	97666
April 2	—82403	+28482	+104251
April 6	— 91760	+38571	+109864
10	99615	49935	114337
14	105605	62264	117366
18	—109244	+74951	+118576

The differential-coefficients were computed by the usual method,* and integrated by the formula (P) of the *Mécanique Céleste*, Book IX., commencing the integral with March 1. To facilitate the subsequent comparisons of theory with observation, the epoch of the new ephemeris was taken at $0^{d}.3$, M. T. Berlin, and for this epoch the following table of instantaneous elements interpolated from the values obtained by direct computation: —

* See also *Astr. Nachr.*, No. 250.

* *Comet of* 1807, and *Astr. Nachr.*, No. 575. In the latter place, however, the value of $D_t h$ should be $- r\mathbf{B}'k$, the negative sign having been erroneously omitted.

	T	n	ω	i	Log. q
d. March 1.3	d. Feb. 27.456130	$1^\circ\ 29'\ 41''.53$	$82^\circ\ 49'\ 56''.61$	$144^\circ\ 22'\ 18''.35$	7.7380201
5.3	130	41.68	56.73	18.39	199
9.3	130	42.13	57.07	18.48	196
13.3	131	42.86	57.65	18.63	194
17.3	132	43.91	58.51	18.82	192
21.3	134	45.31	59.64	19.06	189
25.3	138	47.07	50 1.05	19.36	183
29.3	144	49.20	2.76	19.70	173
April 2.3	152	51.71	4.76	20.10	157
6.3	163	54.59	7.04	20.55	131
10.3	178	57.83	9.59	21.04	101
14.3	195	30 1.40	12.37	21.58	057
18.3	216	5.26	15.35	22.15	000

$$\log. e = 9.9999951.$$

§ 6.

To the variations of n were now added the reductions to the apparent equinox of the several dates, and, with the variations also of i and of ε, the obliquity of the ecliptic, the corresponding changes of $A, B, C, l \sin a, l \sin b, l \sin c$, were computed by the following formulas, derived in part from BESSEL,* and in part from NICOLAI; † M denoting here the modulus of the system of common logarithms.

$$D_n A = \cos i \,.\, \operatorname{cosec}^2 a, \qquad D_i A = -\sin A \,.\, \cot a,$$

$$D_n B = \cos \varepsilon \,.\, \cos c \,.\, \operatorname{cosec}^2 b, \qquad D_i B = -\sin B \,.\, \cot b, \qquad D_\varepsilon B = \cos a \,.\, \operatorname{cosec}^2 b$$

$$D_n C = -\sin \varepsilon \,.\, \cos b \,.\, \operatorname{cosec}^2 c, \qquad D_i C = -\sin C \,.\, \cot c, \qquad D_\varepsilon C = \cos a \,.\, \operatorname{cosec}^2 c$$

$$D_n l \sin a = M \sin 1'' \,.\, \sin i \,.\, D_i A, \qquad D_i l \sin a = M \sin 1'' \,.\, \cot A \,.\, D_i A,$$

$$D_n l \sin b = M \sin 1'' \,.\, \sin i \,.\, D_i B, \qquad D_i l \sin b = M \sin 1'' \,.\, \cot B \,.\, D_i B, \qquad D_\varepsilon l \sin b = M \sin 1'' \,.\, \cot b \,.\, \operatorname{cosec} b \,.\, \cos c$$

$$D_n l \sin c = M \sin 1'' \,.\, \sin i \,.\, D_i C, \qquad D_i l \sin c = M \sin 1'' \,.\, \cot C \,.\, D_i C, \qquad D_\varepsilon l \sin c = M \sin 1'' \,.\, \cos b \,.\, \operatorname{cosec} c \,.\, \cot c.$$

According to Dr. BUSCH,* the observed error of the sun's tabular longitude during March and April, 1843, was $-2''.74$, and the same amount is indicated by other observers.† The differential-coefficients of the variations of the geocentric place of the comet with respect to those of the sun's place are, —

	$D_L\,\alpha$	$D_L\,\delta$	$D_R\,\alpha$	$D_R\,\delta$
March 3	1.059	0.489	-1.094	0.365
27	0.486	0.385	-2.629	0.427
April 16	0.361	0.222	-1.755	0.504

The unknown error, therefore, of the tabular radius-vector is, comparatively, of more importance than that of the longitude. It will not be difficult, when both are obtained, to estimate their effect upon the elements of the comet's orbit, but for the present we must be content to adopt the tabular values.

In computing the ephemeris, correction was made of a slight error of method which had escaped unnoticed in the previous computations; and a few changes were also made, as indicated below, in the list of observations, which changes are mostly due to the detection of errors in the original communications of the observers.

Proceeding now with the comparison of our theory with observation, we have the following table of observed errors of ephemeris, in which the numbers inclosed in parentheses have been rejected from the subsequent discussion.

The anomalies and radius-vectors were first computed by the method of GAUSS (*Theoria Motûs*, p. 39). The parabolic anomaly, not being readily furnished by BARKER's table, was obtained by the formulas of NICOLAI, ‡ and the logarithms of the quantities $\frac{1}{\sqrt{(1-0.8\,A+C)}}$ and $\frac{1-0.8\,A+C}{1+0.2\,A+C}$ were taken from a MS. table with the argument A. The computation was then controlled by calculating the parabolic anomaly and reduction to ellipse by the methods of BESSEL. §

* *Astr. Nachr.*, No. 560.

† In the *Radcliffe Observations* for 1843, the error is given as $= -9''.2$. The discrepancy may be attributed to defects in the old transit instrument, since it entirely disappears after the erection of the new one in October of the same year.

* *Astr. Jahrb.*, 1810, p. 117. † *Astr. Jahrb.*, 1818, p. 268.

‡ *Astr. Nachr.*, No. 485.

§ *Astr. Nachr.*, No. 520. *Monatl. Corr.*, XII. p. 197.

Date.	Place.	Calc. — Obs. Δα	Δδ	Date.	Place.	Calc. — Obs. Δα	Δδ
March 6	Trevandrum,	(+1055.1)	(—457.8)	March 22	Philadelphia,	— 3.1	+ 24.7
8	"	+ 3.0	+ 81.0		Port Stephens,	+ 16.3	+ 40.0
9	"	+ 36.1	+ 10.2	23	Cracow,	(— 67.5)	(—102.9)
10	"	+ 45.1	(— 33.0)		Kremsmünster,	+ 22.9	— 0.4
11	"	(— 20.9)	+ 20.0		Munich,	+ 2.0	— 6.3
	Philadelphia, (1)	(— 100.6)	(— 32.1)		Philadelphia,	+ 0.8	— 1.8
	Hudson, (1)	(+ 5.7)	(— 19.0)	24	Cracow,	(— 56.3)	(+ 77.7)
13	Trevandrum,	+ 29.3	+ 59.8		Padua,	+ 1.8	+ 28.0
14	"	+ 13.5	+ 59.3		Berlin,	+ 2.9	+ 21.0
15	"	+ 49.6	+ 40.4		Philadelphia,	+ 5.6	+ 13.5
16	"	+ 12.0	+ 49.9	25	Nicolajew,	+ 6.6	+ 22.3
17	"	+ 32.1	+ 41.2		Berlin,	+ 0.3	+ 20.2
	Rome,	+ 11.2	+ 39.2		Prague,	— 4.7	(+160.4)
	Naples,	+ 10.6	+ 24.4		Mannheim,	+ 19.8	(+ 61.9)
	New Haven,	+ 52.9	— 0.9		Bonn,	— 2.6	+ 11.1
18	Trevandrum,	+ 35.8	+ 24.1		Hamburg,	(—159.9)	(+ 92.2)
	Naples,	+ 8.7	+ 15.9		Hudson,	+ 5.7	+ 47.0
	Rome, (2)	+ 40.0	(+171.5)	26	Trevandrum,	+ 46.8	— 10.6
	Geneva,	+ 27.2	— 0.6		Cracow,	(—107.3)	(+ 76.5)
	Paris,	+ 7.7	+ 28.5		Königsberg,	+ 29.2	+ 3.6
	Port Stephens,	+ 28.1	(+ 90.1)		Berlin,	+ 6.5	+ 16.1
19	Trevandrum,	+ 33.7	+ 34.5		Philadelphia,	+ 12.0	— 17.1
	Nicolajew,	+ 9.0	+ 24.7	27	Naples,	+ 13.4	+ 10.4
	Naples,	+ 15.1	+ 2.7		Königsberg,	— 6.5	+ 20.8
	Kremsmünster,	+ 19.4	+ 34.6		Cracow,	(— 29.6)	
	Modena,	(+ 408.0)	+ 35.2		Berlin,	+ 3.6	+ 3.0
	Munich,	(+ 78.7)	(— 32.7)		Rome,	+ 7.7	+ 50.2
	Geneva,	+ 25.0	+ 13.8	28	Naples, (6)	(— 30.6)	(+ 16.9)
	Rome, (3)	+ 3.1	+ 20.1		Cracow,	(— 76.5)	(+ 57.7)
	Paris,	+ 24.0	+ 13.4		Berlin,	— 1.1	+ 5.4
	Philadelphia,	+ 13.1	+ 13.8		Bonn,	+ 3.2	+ 24.7
	Port Stephens,	+ 22.6	+ 3.3		Port Stephens,	+ 22.9	(+ 86.8)
20	Cracow,	+ 22.4	+ 26.5	29	Naples,	(— 55.4)	+ 17.5
	Naples,	+ 2.6	+ 35.0		Cracow,	+ 11.3	(—137.4)
	Kremsmünster,	+ 14.7	+ 47.3		Königsberg,	— 22.6	(— 42.9)
	Rome, (4)	+ 22.7	(— 23.9)		Berlin,	— 3.8	+ 0.5
	Munich,	+ 15.0	+ 28.7		Modena,	+ 8.0	+ 46.6
	Modena,	+ 25.6	— 8.4		Prague,	— 0.7	(+ 81.3)
	Berlin,	+ 13.6	+ 17.8		Padua,	— 35.3	+ 38.7
	New Haven,	+ 14.1	(— 41.3)		Bonn,	— 6.1	+ 11.8
21	Cracow,	(— 41.0)	(— 31.4)		Mannheim,	— 2.7	+ 9.5
	Kremsmünster,	+ 11.0	+ 42.5		New Haven,	+ 39.7	
	Naples,	+ 12.9	+ 32.9	30	Cracow,	(— 86.5)	
	Vienna,	— 18.2	— 0.2		Modena,	+ 18.6	+ 27.9
	Munich,	+ 31.3	+ 58.5		Naples,	+ 12.1	+ 15.5
	Geneva,	+ 11.4	+ 27.0		Berlin,	+ 8.8	+ 12.9
	Berlin,	+ 16.0	+ 19.1		Kremsmünster,	+ 32.2	+ 12.3
	Mannheim,	+ 18.3	+ 29.3		Munich,	— 8.3	+ 35.1
	Bonn,	— 6.9	+ 44.3		Rome,	+ 15.2	+ 32.5
	New Haven,	+ 50.3	(— 15.5)		Prague,	— 22.4	+ 28.6
	Hudson,	+ 65.3	+ 54.1		Mannheim,	— 12.3	
22	Nicolajew,	+ 18.3	+ 23.3		Geneva,	+ 21.7	+ 15.9
	Vienna,	— 0.7	+ 15.7	31	Nicolajew,	— 3.7	+ 1.5
	Cracow,	(— 44.5)	(+ 64.5)		Naples,	+ 18.5	+ 1.0
	Munich,	— 28.6	+ 29.9		Vienna,	— 20.1	
	Kremsmünster, (5)	+ 27.2	+ 28.1		Berlin,	— 11.2	— 8.2
	Naples,	+ 16.9	+ 8.1		Rome,	— 2.9	+ 25.6
	Berlin,	+ 7.9	+ 21.1		Prague,	— 7.6	— 16.4

(1) Instrumental positions. (2) M. T. should be .30974. (6) No stars of comparison

(3) M. T. should be .32886. (4) M. T. should be .31494

(5) Rejecting the second observation of this date (*Astr. Nachr.*, No. 504), we have $\alpha = 49° 1' 55''.7$; $\delta = 8° 40' 11''.1$.

Date.	Place.	Calc. — Obs. $\Delta\alpha$	Calc. — Obs. $\Delta\delta$	Date.	Place.	Calc. — Obs. $\Delta\alpha$	Calc. — Obs. $\Delta\delta$
April 1	Naples,	$+12''.5$	$+0''.6$	April 3	Kremsmünster,	$+44''.5$	$(+85''.1)$
	Vienna,	-29.2	-31.4	5	Rome,	$+8.5$	$+2.3$
	Kremsmünster,	$+28.9$	$+16.2$		Hudson,	-12.7	-24.9
	Rome, (1)	-21.4	-27.1	6	Rome,	$+33.9$	-37.9
	Padua,	-43.7	$-22\ 3$		Naples,	-59.5	-26.5
	Prague,	-20.8	$(+53.5)$		Hudson,	-30.5	-51.7
	Philadelphia, (2)	$+18.0$		7	Naples,	$(+116.8)$	$(+43.2)$
	Hudson,	$+20.5$	$+17.0$		Philadelphia,	$+8.4$	
2	Kremsmünster,	$+16.9$	-21.3	9	Philadelphia,	$+19.9$	$+50.5$
	Padua,	-26.4	-11.8	10	Philadelphia,	(-57.4)	$(+65.0)$
	Philadelphia,	-14.5	$+5.8$	15	Berlin,	$+23.1$	-19.9

(1) Rejecting the first observation in α of this date (*Astr. Nachr.*, No. 478), we have $\alpha = 61^{\circ}\,44'\,22''.1$; the δ should be $= 6^{\circ}\,13'\,17''.9$.

(2) M. T. should be .57153.

It is immediately evident, on inspecting the above list, that any method of assigning weights to the equations now to be formed must be more than usually arbitrary. The observations have been made at many different places, the greater part with the ring-micrometer, the remainder in various ways, not all of which have been fully explained. On the average, there are but seven available observations from each astronomer; but one observer has more than twelve; a determination of weights founded on an investigation of probable errors is, therefore, entirely out of the question. The peculiar atmospherical difficulties nearly outweighed all other sources of error, and were common to all the observers, and I at last decided, after exercising somewhat large discretion in the rejection of individual observations, to consider all the remainder as of equal value. Where several observations made on the same day were combined, the mean received a weight proportional to the square root of the number thus combined.

I now computed the coefficients of the new equations of condition for every second day from March 7 to April 16, controlling one or two dates by BESSEL's formulas, and examining the rest by differences: from the results the equations, sixty-one in number, were formed for each date by interpolation.

(To be continued.)

ON AN ERROR IN THE GREENWICH PLANETARY REDUCTIONS.

BY ERNEST SCHUBERT.

Cambridge, April 5, 1850.

To LIEUT. CHARLES HENRY DAVIS,

SUPERINTENDENT NAUTICAL ALMANAC, CAMBRIDGE, MASS.

SIR, — I have the honor to call your attention to the following statement of the result of certain reductions of the Greenwich observations of Mars since the year 1750, made under your direction, as a part of the labor of preparing a new theory and tables of that planet.

In the volume of the "Reduction of Greenwich Observations of Planets from 1750 to 1830," the following are given as the equatorial intervals of the wires of the transit instrument, from December 20, 1762, to March 2, 1765, (Introd., Sect. 1, p. v.,) viz.: —

(IX.) 1762, December 20, to March 2, 1765.

1st	wire	+71.41
2d	"	+35.87
3d	"	0.00
4th	"	—35.79
5th	"	—71.38

It is said in the Introduction, that these "are the corrections for each wire, which have been actually employed; applicable to a star in the equator."

Upon revising the reductions of the observed wires by means of the accompanying stars, for January 14, 1764, (the observations of Mr. BLISS,) I found the following discrepancies, viz.: —

		h. m. s.	m. s.	m. s.	m. s.	m. s.
α Virginis.	Observed Wires.	13 11 44.00	12 19.75	12 56.00	13 32.00	14 7.75
	Reduced Wires.	13 12 56.50	12 56.16		12 55.67	12 55.29
α Boötis.		14 3 47.25	4 25.00	5 3.00	5 41.00	6 18.75
		14 5 3.45	5 3.27		5 2.81	5 2.58

		h. m. s.	m. s.	m. s.	m. s.	m. s.
2*α Libræ.*	Observed Wires.	14 36 47.00	37 23.00	38 0.00	38 37.00	39 13.00
	Reduced Wires.	14 38 0.93	38 0.14		37 59.95	37 59.10
Mars.		14	27 24.75	28 1.25		29 14.25
		14	28 1.64			28 0.85

It being apparent from this, that the intervals given in the volume of "Reductions," &c., are too great, I have deduced the following corrected equatorial intervals from observations in 1764.

Intervals of Transit Wires.

1764.	I.	II.	IV.	V.
	s.	s.	s.	s.
Jan. 1, α Tauri,	+71.13	+35.56	—35.56	
β Orionis,	70.72	35.80	35.41	—70.72
β Tauri,	70.82	35.63	35.63	70.82
α Orionis,	(70.12)	35.41	35.70	(71.41)
α Can. Maj.,	70.70	35.49	35.49	70.98
May 7, α Orionis,	70.90	35.70	35.70	71.21
α Can. Maj.,	70.98	35.78	35.68	70.51
α Can. Min.,	70.93	35.32	35.52	70.34
α Leonis,	71.10	35.74	35.84	71.10
α Virginis,	70.72	35.46	35.46	70.43
Sept. 14, α Can. Min.,	71.33		35.12	70.43
16, γ Aquilæ,	70.89	35.94	35.45	70.89
β Aquilæ,	71.13	35.81	35.32	70.63
24, α Boötis,	70.29	35.33	35.61	71.22
25, γ Aquilæ,	71.19	35.74	35.45	70.60
β Aquilæ,	71.13	(36.11)	35.52	70.34
Nov. 10, α Tauri,	+71.13	+35.56	—35.08	—71.13
Mean,	+70.943	+35.618	—35.502	—70.757
18 observations of α Aurigæ; mean,	70.847	35.458	35.583	70.888
24 " " β Geminorum; mean,	+70.720	+35.543	—35.547	—70.723
Mean of means,	+70.837	+35.540	—35.544	—70.789

With these intervals the reduced wires above given are, —

	α Virginis.	2 α Boötis.	α Libræ.	Mars.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
I.	13 12 55.91	14 5 2.84	14 38 0.34	
II.	55.83	2.92	37 59.78	14 28 1.30
III.	56.00	3.00	38 0.00	1.25
IV.	55.92	3.07	0.20	1.46
V.	55.89	3.22	37 59.71	

I have already called your attention to certain discrepancies between the observed and reduced values of the place of this planet, particularly in right ascension, in the observations of Bradley and Maskelyne.

Very respectfully,

Your obedient servant,

E. SCHUBERT.

ON THE LONGITUDE OF HUDSON (OHIO) OBSERVATORY.

By ELIAS LOOMIS,

PROFESSOR OF MATHEMATICS AND NATURAL PHILOSOPHY IN THE UNIVERSITY OF THE CITY OF NEW YORK.

The Hudson Observatory was erected in the summer of 1838. It is furnished with an equatorial telescope of sixty-six inches' focus, and about four inches aperture; the right-ascension circle reading by verniers to a single second of time, and the declination-circle to ten seconds of arc. It has also a transit-circle, the telescope being thirty inches' focus, and about three inches of aperture. The circle is eighteen inches in diameter, graduated on platinum to five minutes, and has three reading-microscopes, each measuring single seconds. The clock has a mercurial pendulum, and loses no time in winding.

During the six years in which I had the charge of this Observatory, I observed two hundred and sixty culminations of the moon, together with certain stars near the same parallel, generally the moon-culminating stars of the Nautical Almanac.

I expected that, by a comparison of these observations with similar ones made in Europe, the longitude of the Observatory would be determined with considerable precision. This comparison has been delayed by the difficulty of obtaining the corresponding European observations. The Greenwich and Oxford observations are published with a most praiseworthy promptness. The publication of the Cambridge and Edinburgh observations is considerably in arrears; but through the politeness of Professors CHALLIS and SMYTH, I have been furnished with the corresponding observations in manuscript from those stations, for the years which have not been published. The moon culminations at Hamburg are given in SCHUMACHER'S *Astronomische Nachrichten*. The following tables exhibit the results of all the comparisons which have been obtained with the observations of Greenwich, Cambridge, Edinburgh, Oxford, and Hamburg: —

GREENWICH AND HUDSON.

Moon's First Limb.

Date.	Observed Increase of R A.	Computed Longitude.	Date.	Observed Increase of R A.	Computed Longitude.	Date.	Observed Increase of R A.	Computed Longitude.
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1839, Jan. 24	14 4.47	5 25 44.7	1840, June 8	10 17.12	5 25 48.5	1842, June 21	13 26.48	5 25 35.2
March 23	13 5.77	27.7	13	12 20.69	40.8	July 15	12 39.29	32.6
21	12 5.31	29.3	July 9	11 43.19	44.1	16	13 2.93	47.7
25	11 10.57	36.0	13	12 23.70	29.7	21	11 46.34	34.0
27	9 58.79	36.7	Aug. 4	11 8.95	33.5	Aug. 13	13 20.26	39.5
April 20	12 37.40	39.7	5	11 36.33	40.0	16	12 33.43	42.6
24	9 45.90	49.8	8	12 38.03	52.6	19	10 39.39	35.6
25	9 41.75	40.1	Sept. 6	12 17.95	41.3	20	10 13.36	34.4
26	9 52.07	30.1	7	11 55.40	46.3	Sept. 12	12 48.85	38.8
May 25	10 40.19	35.1	Oct. 6	11 13.38	42.0	13	12 7.72	49.7
26	11 22.93	33.3	7	11 3.42	41.5	16	10 19.90	47.0
June 24	12 42.52	49.8	Nov. 2	11 6.46	37.9	Oct. 11	11 46.02	30.7
July 22	13 5.56	52.2	3	10 52.22	46.3	13	10 29.15	49.4
24	13 33.39	36.9	Dec. 2	10 36.69	32.0	1843, April 10	12 38.21	33.8
25	13 12.95	29.7	1841, April 2	11 55.91	38.6	11	12 44.17	37.1
Aug. 20	13 30.53	48.2	3	11 32.68	29.8	12	13 2.59	39.0
21	13 23.44	36.0	27	13 33.25	40.0	May 11	13 34.77	40.2
23	12 31.57	39.9	28	12 40.91	42.1	June 8	13 34.86	43.6
Oct. 14	12 55.88	48.3	May 27	11 34.32	47.4	July 8	14 24.13	39.1
15	12 45.20	43.7	28	11 11.55	48.5	Aug. 5	14 0.11	35 8
16	12 25.90	45.1	June 30	12 35.17	48.8	Sept. 29	14 0.82	45.8
Nov. 16	11 41.69	43.3	July 26	12 14.82	40.3	Oct. 4	10 31.89	29.9
18	13 7.59	36.7	28	12 36.77	35.6	5	10 17.13	32.9
19	14 14.89	27.1	Oct. 25	10 13.69	32.7	1844, Feb. 27	12 26.07	38.2
1840, March 13	13 10.95	38.0	1842, April 20	12 20.76	44.3	May 23	11 30.49	43.2
April 8	14 32 99	39.3	24	13 13.75	34.9	27	12 43.91	40.2
11	11 25.72	28.5	May 20	12 17.78	47.2	June 24	12 46.01	37.1
13	10 23.62	41.2	June 13	12 27.23	43.9	July 23	13 44.91	39.0
15	10 24.51	5 25 46.9	17	12 21.78	5 25 37.0	24	14 25.14	5 25 39.5

Mean of 87 determinations from moon's first limb, $5^{h.}\ 25^{m.}\ 39^{s.}.8$.

Moon's Second Limb.

Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1839, July 28	11 43.49	5 25 44.2	1840, Sept. 17	15 7.98	5 25 46.4	1842, Aug. 23	10 4.68	5 25 44.3
Aug. 2	13 50.37	42.1	Oct. 12	13 54.71	35.6	Oct. 23	13 33.31	43.8
25	11 51.67	50.8	13	14 50.46	28.9	25	13 12.70	46.6
Oct. 24	15 29.07	34.3	Nov. 10	15 43.89	44.3	26	12 50.50	49.1
Nov. 22	15 53.16	31.9	16	11 11.17	42.9	Nov. 25	12 2.76	39.5
1840, April 19	12 13.26	50.6	1841, June 4	12 39.28	47.7	Dec. 17	14 3.20	53.2
July 15	11 28.63	46.7	6	11 46.17	39.7	23	12 2.68	45.7
16	11 2.48	41.8	July 3	11 56.99	48.5	1843, Sept. 16	12 48.22	43.8
Aug. 4	10 51.92	40.0	1842, April 24	13 14.84	55.0	Oct. 16	12 22.57	50.5
Sept. 12	11 28.00	40.0	28	13 3.76	54.9	Dec. 13	11 51.36	5 25 51.8
13	12 4.58	5 25 41.6	June 28	9 55.25	5 25 44.3			

Mean of 32 determinations from moon's second limb, $5^{h.}\ 25^{m.}\ 44^{s}.4$.

CAMBRIDGE (ENG.) AND HUDSON.

Moon's First Limb.

Date.	Observed Increase of R.A.	Computed Longitude	Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1838, Nov. 29	13 49.80	5 25 65.9	1839, Oct. 18	11 55.69	5 25 73.7	1842, April 20	12 21.78	5 25 71.2
1839, Jan. 24	14 5.29	63.9	20	12 16.50	58.9	June 13	12 28.13	67.4
Feb. 19	13 21.47	56.2	Nov. 16	11 42.63	69.6	20	13 32.76	57.0
21	14 19.39	52.9	18	13 8.46	58.5	21	13 27.72	65.2
March 24	12 6.33	56.6	1840, March 13	13 12.10	67.2	July 15	12 40.22	56.6
25	11 11.72	69.5	April 8	14 34.24	67.9	16	13 3.40	59.5
27	9 59.35	55.0	9	13 29.70	71.9	21	11 47.60	68.5
April 19	13 47.26	61.7	11	11 26.70	56.8	Aug. 16	12 34.22	63.0
20	12 38.50	67.9	13	10 24.51	68.9	19	10 40.17	59.4
21	11 33.50	64.2	15	10 25.31	71.8	20	10 14.16	59.8
24	9 46.50	69.7	June 8	10 17.87	72.1	Sept. 12	12 49.98	67.3
25	9 42.28	57.9	13	12 21.78	68.8	16	10 20.77	74.3
27	10 17.24	67.9	July 10	12 14.27	75.5	Oct. 13	10 29.64	64.6
May 25	10 40.82	54.4	11	12 34.11	68.2	1843, April 12	13 3.33	57.5
26	11 23.66	54.3	13	12 24.84	58.8	July 8	14 25.12	61.4
June 24	12 43.44	73.5	Aug. 4	11 10.08	66.8	Aug. 5	14 1.23	61.8
July 18	10 7.18	50.5	6	12 5.90	64.8	Sept. 29	14 1.68	65.6
22	13 6.54	76.7	7	12 28.36	59.6	Oct. 2	11 38.41	68.0
Aug. 20	13 31.28	66.4	8	12 38.59	67.1	4	10 32.61	51.2
21	13 24.32	57.3	9	12 32.82	72.6	5	10 17.84	58.0
22	13 1.07	52.2	11	11 46.34	67.7	1844, Feb. 24	11 29.20	76.0
23	12 32.72	69.7	Oct. 6	11 14.17	65.0	May 23	11 30.91	55.1
Oct. 14	12 56.68	68.5	7	11 4.11	61.5	27	12 44.61	58.4
15	12 46.23	70.0	Nov. 2	11 7.34	63.9	July 23	13 45.81	60.4
16	12 26.82	5 25 69.2	Dec. 2	10 37.65	5 25 62.4	24	14 26.00	5 25 58.9

Mean of 75 determinations from moon's first limb, $5^{h.}\ 26^{m.}\ 3^{s.}.9$.

Moon's Second Limb.

Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1839, Aug. 2	13 51.18	5 25 62.1	1840, Sept. 12	11 28.50	5 25 51.5	1842, Aug. 22	9 56.28	5 25 77.4
25	11 55.11	62.8	13	12 5.40	61.3	23	10 5.39	67.2
Oct. 24	15 30.45	63.9	Oct. 12	13 55.74	60.2	Sept. 19	10 3.89	59.1
Nov. 22	15 54.44	57.8	Nov. 9	14 50.90	60.8	Oct. 27	12 32.65	66.7
1840, July 15	11 29.34	67.5	10	15 45.03	65.3	Nov. 25	12 3.51	59.7
16	11 3.23	65.3	16	11 12.11	72.8	Dec. 17	14 3.98	5 25 71.4
Aug. 14	10 52.86	5 25 68.7	1842, Aug. 20	10 11.22	5 25 77.9			

Mean of 20 determinations from moon's second limb, $5^{h.}\ 26^{m.}\ 5^{s.}.3$.

EDINBURGH AND HUDSON.

Moon's First Limb.

Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1838, Sept. 29	12 54.61	5 12 44.5	1839, Feb. 19	12 49.33	5 12 44.6	1839, April 18	11 9.10	5 12 59.6
Oct. 1	12 7.75	49.5	March 22	13 27.34	49.8	19	13 13.75	52.8
27	12 10.52	60.9	23	12 34.94	44.7	21	11 5.21	50.0
Nov. 29	13 16.35	48.6	24	11 36.82	45.5	24	9 22.72	54.5
1839, Jan. 24	13 13.41	5 12 53.0	25	10 41.29	5 12 53.0	26	9 29.67	5 12 65.2

Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1839, April 27	9 52.67	5 12 61.0	1840, Oct. 6	10 46.76	5 12 51.6	1842, June 21	11 18.80	5 12 57.3
May 25	10 15.13	44.0	7	10 37.27	51.8	Aug. 13	12 49.16	59.3
June 20	9 37.27	60.0	Nov. 5	10 39.68	71.5	16	12 3.73	56.2
Aug. 20	12 58.66	56.1	6	11 10.80	55.6	19	10 14.15	48.6
Oct. 17	11 37.59	48.9	30	10 16.64	49.8	20	9 49.33	52.1
18	11 27.00	66.1	Dec. 1	10 7.12	56.2	Sept. 16	9 55.41	58.1
20	11 46.87	45.2	2	10 11.69	44.0	17	9 38.51	47.5
Nov. 16	11 14.42	57.8	1841, March 3	13 47.45	56.4	18	9 33.09	44.8
17	11 45.73	45.0	April 1	12 4.59	46.9	Oct. 11	11 18.38	51.8
19	13 42.22	50.6	2	11 27.48	45.9	12	10 36.22	44.7
1840, March 11	14 17.77	49.8	27	13 5.97	55.7	15	9 34.19	42.9
13	12 39.47	47.5	28	12 10.82	55.9	Dec. 12	10 26.10	46.3
17	10 2.61	53.7	May 27	11 6.81	56.7	1843, Jan. 9	10 39.18	45.8
April 9	12 56.53	57.4	28	10 45.09	60.6	March 13	12 34.12	47.7
13	9 59.37	63.1	29	10 40.09	49.8	April 7	12 31.85	45.0
15	10 0.07	59.9	June 2	12 0.48	52.2	10	12 8.46	47.4
June 13	11 52.12	64.1	July 28	12 7.14	50.2	12	12 32.10	55.1
July 10	11 44.68	63.6	Oct. 25	9 49.77	51.1	May 11	14 2.95	52.8
Aug. 6	11 36.88	59.4	26	9 59.70	52.1	Aug. 5	13 27.21	52.1
8	12 8.01	57.9	1842, April 20	11 51.60	56.4	Oct. 2	11 9.98	56.7
9	12 2.50	65.5	21	11 46.08	43.2	4	10 6.95	42.0
11	11 17.85	62.0	June 13	11 57.75	56.7	Dec. 3	10 46.03	45.7
Sept. 7	11 27.26	60.0	15	12 9.68	48.5	4	11 15.31	42.9
Oct. 3	11 48.53	5 12 45.9	16	12 32.05	5 12 54.4	1844, May 23	11 3.07	5 12 47.7

Mean of 87 determinations from moon's first limb, $5^{h.}\ 12^{m.}\ 52^{s.}.7$.

Moon's Second Limb.

Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1839, July 4	12 0.02	5 12 63.2	1840, Nov. 16	10 44.91	5 12 65.5	1842, Sept. 28	12 57.24	5 12 55.0
Aug. 2	13 18.33	65.9	1841, June 4	12 9.53	62.8	Oct. 26	12 20.43	68.6
1840, March 17	10 3.02	66.5	Aug. 2	10 8.21	65.8	27	12 2.28	58.7
July 16	10 36.69	65.3	1842, Aug. 20	9 49.33	67.9	Dec. 17	13 30.02	63.5
Sept. 13	11 36.51	60.2	21	9 34.85	60.8	1843, Jan. 24	13 10.13	58.3
Oct. 12	13 22.56	57.1	22	9 32.25	68.3	Sept. 16	12 17.98	5 12 53.4
Nov. 10	15 7.43	5 12 64.0	Sept. 27	13 11.78	5 12 67.7			

Mean of 20 determinations from moon's second limb, $5^{h.}\ 13^{m.}\ 2^{s.}.9$.

(*Continued on the next page.*)

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ADVERTISEMENT.

Communications for the Astronomical Journal will be addressed to the Editor, B. A. Gould, Jr., Cambridge, Mass. A volume will consist of twenty-four numbers, with a table of contents and alphabetical index. The price of subscription is $ 5.00, payable in advance, which may be sent either to the Editor, to the Publishers, Messrs. James Munroe & Co., Cambridge and Boston, or, in England, to Mr. John Chapman, London. Subscribers in France and Germany are requested to state in what way they prefer to have the Journal sent them.

THE

ASTRONOMICAL JOURNAL.

No. 9.

VOL. I. CAMBRIDGE, MAY 27, 1850. NO. 9.

ON THE LONGITUDE OF HUDSON (OHIO) OBSERVATORY.

By ELIAS LOOMIS,

PROFESSOR OF MATHEMATICS AND NATURAL PHILOSOPHY IN THE UNIVERSITY OF THE CITY OF NEW YORK.

(*Continued from page* 64.)

OXFORD AND HUDSON.

Moon's First Limb.

Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1840, April 9	13 15.90	5 20 40.9	1840, Dec. 1	10 21.63	5 20 24.0	1842, Sept. 12	12 37.19	5 20 44.0
June 8	10 7.63	48.0	2	10 26.76	26.9	13	11 56.01	37.2
13	12 9.30	39.3	1841, April 27	13 25.40	36.8	Oct. 13	10 18.87	31.8
July 13	12 12.16	27.4	June 29	12 6.27	35.1	1843, April 10	12 26.40	29.5
Aug. 8	12 25.86	38.8	Oct. 25	10 4.12	28.1	11	12 32.00	25.7
Sept. 7	11 43.90	33.3	1842, April 20	12 8.85	30.6	12	12 50.10	26.0
Oct. 6	11 2.62	30.7	21	12 3.51	27.1	July 8	14 10.33	26.9
7	10 52.84	30.0	June 21	13 13.72	27.4	Aug. 5	13 46.82	27.4
Nov. 2	10 55.81	26.7	July 16	12 50.18	28.5	1844, May 27	12 32.13	37.5
6	11 27.08	34.1	Aug. 16	12 21.29	29.7	July 23	13 32.08	33.2
9	14 34.28	5 20 25.2	19	10 29.29	5 20 28.6	24	14 11.51	5 20 30.3

Mean of 33 determinations from moon's first limb, $5^{h.}\ 20^{m.}\ 31^{s.}.7$.

Moon's Second Limb.

Date.	Observed Increase of R.A	Computed Longitude.	Date.	Observed Increase of R.A	Computed Longitude.	Date.	Observed Increase of R.A	Computed Longitude
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1840, July 15	11 17.68	5 20 37.4	1840, Nov. 9	14 36.88	5 20 52.0	1841, June 4	12 27.23	5 20 37.7
Aug. 14	10 42.12	46.3	- 10	15 29.47	5 20 44.5	1842, Dec. 17	13 49.78	5 20 41.7
Oct. 12	13 42.08	5 20 37.6						

Mean of 7 determinations from moon's second limb, $5^{h.}\ 20^{m.}\ 42^{s.}.5$.

HAMBURG AND HUDSON.

Rümker's Observations.

Moon's First Limb.

Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1838, Sept. 27	15 52.95	6 5 35.9	1840, May 10	11 44.41	6 5 36.4	1842, April 21	13 44.96	6 5 23.0
29	15 5.90	32.2	June 8	11 32.57	39.0	24	14 50.33	23.0
Nov. 29	15 29.93	45.5	11	12 42.55	37.9	May 20	13 47.83	42.4
1839, Jan. 24	15 47.46	40.4	Aug. 6	13 32.84	20.9	July 16	14 38.13	33.1
Feb. 19	14 57.82	21.3	7	13 58.67	26.8	17	14 56.76	45.8
21	16 3.52	21.9	Sept. 6	13 48.42	29.7	Aug. 16	14 5.77	23.7
March 22	15 44.21	33.2	Oct. 6	12 35.85	28.1	19	11 58.54	38.7
24	13 35.32	28.3	7	12 24.60	30.4	20	11 28.92	30.4
25	12 33.92	41.7	Dec. 2	11 54.35	21.0	Sept. 13	13 37.37	40.0
April 20	14 11.11	30.0	1841, March 2	16 50.12	33.0	16	11 36.40	47.4
May 25	11 57.74	21.6	3	16 7.46	31.4	17	11 16.36	33.6
June 20	11 13.43	22.1	30	15 59.79	24.0	Oct. 16	11 15.41	39.8
25	14 54.73	43.9	April 1	14 7.78	33.4	1843, April 12	14 38.00	30.4
July 17	11 10.64	33.0	3	12 57.58	33.0	July 7	15 55.05	36.1
Aug. 20	15 9.59	38.9	May 27	12 59.66	35.3	Aug. 5	15 43.48	34.1
Oct. 20	13 45.36	30.9	28	12 33.82	36.5	1844, Feb. 27	13 57.31	31.7
21	14 27.60	28.8	June 2	14 1.38	33.9	May 23	12 54.81	27.1
Nov. 18	14 43.03	29.4	28	13 20.55	30.3	27	14 16.55	27.7
1840, March 11	16 42.35	22.7	July 28	14 9.57	31.3	June 24	14 19.02	27.9
April 13	11 40.18	32.7	29	13 59.77	29.4	July 23	15 25.27	35.2
15	11 40.76	6 5 39.6	Oct. 25	11 29.15	6 5 35.5	24	16 10.40	6 5 29.0

Mean of 63 determinations from moon's first limb, $6^{h.}$ $5^{m.}$ $32^{s.}.3$.

Moon's Second Limb.

Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1839, May 5	14 0.58	6 5 31.0	1839, Aug. 25	13 22.35	6 5 46.7	1842, Dec. 17	15 46.33	6 5 45.2
Aug. 2	15 31.26	6 5 34.8	Oct. 22	15 29.17	6 5 37.9	1843, Jan. 24	15 22.59	6 5 29.6

Mean of 6 determinations from moon's second limb, $6^{h.}$ $5^{m.}$ $37^{s.}.5$.

HAMBURG AND HUDSON.

Weyer's Observations.

Moon's First Limb.

Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.	Date.	Observed Increase of R.A.	Computed Longitude.
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1842, April 21	13 44.89	6 5 21.1	1842, Aug. 19	11 58.22	6 5 29.0	1842, Sept. 18	11 9.55	6 5 22.8
24	14 50.45	26.0	20	11 28.73	24.2	Oct. 16	11 14.99	26.1
May 20	13 47.87	43.5	Sept. 13	13 37.38	40.2	1843, Jan. 9	12 26.48	41.3
July 17	14 56.45	38.3	16	11 36.13	38.9	May 11	15 13.82	31.2
Aug. 16	14 6.16	6 5 33.9	17	11 16.14	6 5 26.5	Aug. 5	15 43.05	6 5 24.1

Mean of 15 determinations from moon's first limb, $6^{h.}$ $5^{m.}$ $31^{s.}.1$.

Moon's Second Limb.

Date.	Observed Increase of R A.	Computed Longitude.	Date.	Observed Increase of R A.	Computed Longitude.	Date.	Observed Increase of R A.	Computed Longitude.
	m. s.	h. m. s.		m. s.	h. m. s.		m. s.	h. m. s.
1842, Aug. 21	11 11.58	6 5 33.9	1842, Sept. 19	11 17.45	6 5 47.2	1842, Dec. 17	15 46.33	6 5 44.0
23	11 18.63	6 5 42.0						

Mean of 4 determinations from moon's second limb, $6^{h.}\ 5^{m.}\ 41^{s.}.8$.

Combining all the Hamburg Observations, we obtain, —

Mean of 78 determinations from moon's first limb, $6^{h.}\ 5^{m.}\ 32^{s.}.1$.

Mean of 10 determinations from moon's second limb, $6^{h.}\ 5^{m.}\ 39^{s.}.2$.

Assuming the longitudes of the preceding observatories to be as follows: —

	m. s.
Cambridge (Eng.),	— 0 23.5
Edinburgh,	+12 43.6
Oxford,	+ 5 2.6
Hamburg,	—39 51.1

we obtain the following

Results.

	First Limb.		Second Limb.		Both Limbs.	
	No. of Obs.	Longitude.	No. of Obs.	Longitude.	No. of Obs.	Longitude.
		h. m. s.		h. m. s.		h. m. s.
Greenwich,	87	5 25 39.7	32	5 25 44.4	119	5 25 42.0
Cambridge (Eng.),	75	40.5	20	41.8	95	41.2
Edinburgh,	87	36.3	20	46.5	107	41.4
Oxford,	33	34.3	7	45.1	40	39.7
Hamburg,	78	5 25 38.0	10	5 25 45.1	88	5 25 41.6
Mean	360	5 25 38.2	89	5 25 44.4	449	5 25 41.3

The difference between the results of observations upon the two limbs of the moon is considerable, and appears to indicate a constant error in the observations. I have thought it right, therefore, to allow equal weight to the results from each limb, notwithstanding the disparity in the number of the observations. The results for Greenwich, Cambridge (Eng.), Edinburgh, and Hamburg, agree with each other as well as could be expected. The results for Oxford may induce the suspicion of a slight error in the assumed longitude of that Observatory. Considering the longitudes of all these observatories as equally well determined, we obtain for the longitude of Hudson Observatory, from the entire series of moon culminations,

$5^{h.}\ 25^{m.}\ 41^{s.}.3$.

ON A MACHINE FOR THE MECHANICAL CALCULATION OF OCCULTATIONS.

By THOMAS HILL.

Several years since, I invented an instrument for the prediction of occultations, and now propose to present the trigonometrical process by which the correctness of the instrument is demonstrated.

If upon the moon's place, on a celestial sphere, a line, equal to the horizontal parallax, be raised, at an elevation from the tangent plane equal to the moon's altitude, and if the projection of this line upon the plane make an angle with the circle of declination equal to the parallactic angle, the projection of the extremity of the line will be the moon's apparent place.

We take, therefore, a plane surface two feet square, and draw upon it, permanently, circles and parallels of declination on a scale of twelve inches to a degree. By means of a numerical table of the values of degrees of right ascension, this is readily used for parts of the heavens not on the equator. Setting this surface level with the circles of declination parallel to the meridian, and mapping in pencil the moon's true place, and also that of the star, the problem becomes to point a rod towards a fictitious moon which has the moon's altitude, and an azimuth equal to the moon's parallactic angle; and to find the projection of the extremity of the rod. The rod is made of two pieces, one graduated and sliding in the other, so that the

length can be made equal to the horizontal parallax. The projection of its extremity is found by a vertical steel bar standing on a brass stand. This bar carries a point in a vertical line over the center of the stand. The circumference of the stand is graduated in degrees, and carries a revolving arm, graduated to minutes of the moon's semidiameter, which by its revolution marks the moon's apparent limb, and upon the graduated limb of the stand measures the angles between the point of contact and the north point, and vertex.

To devise a machine to point the rod. Call the zenith Z, the moon M, the fictitious moon M', the pole P, and by P' designate a point in the meridian on the opposite side of the zenith at an altitude equal to the declination of the moon.

We have by conditions of problem that the angle $P\,M\,Z$ equals $M'\,Z\,P'$, that the side $Z\,M$ equals $Z\,M'$, and that $P\,M$ equals $P'\,Z$. Hence, the triangles $P'\,Z\,M'$ and $P\,Z\,M$ are symmetrical, and M' revolves about P' in the same time that M revolves about P, in a circle whose radius is $P'\,M' = P\,Z$ or the co-latitude.

Waltham, Mass., 1850.

Hence, the machine must give the sliding rod three motions. The principal axis must be set on the map parallel to the circles of declination, and be depressed or elevated by a graduated arc so as to point at P'. On this axis rotates a quadrant to be set by a graduated arc at an angle with the meridian equal to the moon's hour-angle. The edge of this quadrant, which carries the sliding rod, being graduated, the rod may be set to make an angle with the principal axis, equal to the co-latitude; and the projection of its extremity found by the steel bar.

An instrument made by TEMPLE, of Boston, in a very neat manner, has enabled me to calculate all the phases of an occultation in less than half an hour, to the utmost accuracy of which the instrument is capable. The degree of accuracy may be judged of from the scale, which is 5′ to an inch, and the apparent motion of the moon is, consequently, about one tenth of an inch to a minute of time. The errors arising from want of parallelism in the circles of declination may be eliminated, by taking the circle passing through the occulted star as the axis of coördinates in mapping the moon's places.

ELEMENTS OF IRIS.

By ERNEST SCHUBERT.

Cambridge, April 24, 1850.

In 1848, at Berlin, I undertook to determine exactly the orbit of Iris. In order to have elements as approximate as possible for the calculation of the perturbations, the elements were determined according to the method of GAUSS, by means of three normal places: 1847, August 20, — 1848, January 27, and September 30. With the elements thus found, the perturbations by Mars, Jupiter, and Saturn were calculated, and seventy-two observations then compared with the elements. I thus obtained five normal places from 1847, August 24.0, to 1848, December 30.0, M. T. Berlin; and after correcting them for the perturbations formed ten equations of condition for determining the corrections of the elements by the method of the least squares. The result of the whole work was the following pure elliptic orbit: —

1848, January 1.0, M. T. Berlin.

$$
\begin{array}{ll}
M & 330^\circ\ 56'\ 26''.63 \\
\pi & 41\ \ 26\ \ \ 9.98 \\
\Omega & 259\ \ 45\ \ 53.13 \\
i & 5\ \ 28\ \ 17.13 \\
\varphi & 13\ \ 21\ \ 44.60 \\
\mu & 962''.86400 \\
\text{Log. } a & 0.3776278
\end{array}
\left.\begin{array}{l} \\ \\ \\ \end{array}\right\} \text{M. equinox, 1848.0.}
$$

The calculation of the perturbations by Jupiter and Saturn was continued, and in 1849 the elements harmonized well with the observations. An ephemeris computed for 1850 is published in the *Berliner Astron. Jahrbuch*, for 1852. The opposition takes place 1850, May 17, $2^{h.}\ 22^{m.}\ 7^{s.}.2$, M. T. Berlin, with an intensity of light but $= 0.357$. The osculating elements for the opposition are: —

1850, May 16.0, M. T. Berlin.

$$
\begin{array}{ll}
M & 202^\circ\ 34'\ 28''.5 \\
\pi & 41\ \ 24\ \ 10.9 \\
\Omega & 259\ \ 42\ \ 50.1 \\
i & 5\ \ 28\ \ 14.6 \\
\varphi & 13\ \ 25\ \ 49.2 \\
\mu & 963''.31818 \\
\text{Log. } a & 0.3774912.
\end{array}
\left.\begin{array}{l} \\ \\ \end{array}\right\} \text{M. equinox, May 16.0.}
$$

While at Washington in the month of January, I communicated to Lieutenant MAURY and Mr. FERGUSON the ephemeris for 1850. The latter is, at present, engaged in observing Iris, and I am much obliged to both gentlemen for their kindness in sending me directly the observations made up to this time.

I compared the first three of them with my elements. By integrating the perturbations from 1848, January 1.0, to 1850, March 31.0, was obtained,—

	δi	$\delta \Omega$	$\delta \varphi$	$\delta \pi$	$\delta \mu$	$\int \delta \mu$	δM
♃	$-3''.264$	$-291''.222$	$+234''.974$	$-243''.795$	$+0''.41220$	$-82''.165$	$+102.336$
♄	$+0.189$	$-\ 7.578$	$+\ 1.293$	$+\ 17.134$	$+0.00215$	$+\ 2.489$	$-\ 23.013$
♃ + ♄	-3.075	-298.800	$+236.267$	-226.661	$+0.41435$	-79.676	$+\ 79.323$

And the following osculating elements : —

1850, March 31.0, M. T. at Berlin.

M	190° 15′ 34″.8	
π	41 24 16.1	M. equinox, March 31.0.
☊	259 42 47.1	M. equinox, March 31.0.
i	5 28 14.1	
φ	13 25 40.9	
μ	963″.27835	
Log. a	0.3775032	

The observations reduced to the meridian of Berlin, and corrected for refraction, aberration, and parallax are as follows : —

M. T. Berlin.	☊ α	☊ δ
March 28.93723	241° 21′ 16″.62	—24° 41′ 57″.31
March 31.79285	15 4.80	41 8.45
April 4.83507	0 37.08	38 43.06

Calc. — Obs.

$\Delta \alpha$	$\Delta \delta$
$-0''.95$	$+8''.39$
$+1.26$	$+8.43$
$+7.92$	$+7.70$

This result is so satisfactory, that a new correction of the elements is unnecessary, at least for the present. An ephemeris for 1851 shall be published in due season.

NOTE ON THE LONGITUDE AND LATITUDE OF WASHINGTON, D. C.

By JAMES CURLEY,
PROFESSOR IN GEORGETOWN COLLEGE.

[Communicated, with the consent of the writer, by Professor A. D. Bache, to whom it was addressed.]

Georgetown College, D. C., April 15, 1850.

I give below the result of a few observations made in 1846, to determine the latitude and longitude of our Observatory, (the dome). There are seven observation of *Polaris* above and below the pole, and seven of *α Ursæ Majoris.* The refractions were computed by the tables published with the Greenwich observations. The meridian-circle is forty-five inches, reading easily to two tenths of a second of arc.

By Polaris.

1846.		
Sept. 16,	below and above the pole	38° 54′ 27″.39
Oct. 28,	above and below	25.65
Nov. 21,	below and above	24.76
" 25, 26,	" "	25.62
" 28, 29,	" "	25.79
" 29,	above and below	26.27
" 29, 30,	below and above	26.51

α Ursæ Majoris.

1846.		
Sept. 23,	below and above	38° 54′ 26″.00
Oct. 11,	above and below	27.63
" 16,	" "	25.93
" 17, 18,	below and above	26.28
" 19,	" "	25.07
" 24,	above and below	26.11
" 24, 25,	below and above	25.96

Mean of all 38° 54′ 26″.07

By taking the aqueduct as a base (957 feet), and using our astronomical theodolite, which reads to ten seconds, I found the distance from the southeast corner of the middle part of our Observatory to the northwest window of the dome of the Naval Observatory to be 8,764.4 feet, and the angle of position 56° 44′ 40″ southeast. This gives 7,329 feet for the easting from our observatory, and 4,806 feet southing, and by allowing 15 feet that our dome is more to the west and to the north than our place of observation, and 8 feet to center of the Naval-Observatory dome, we have 7,352 and 4,829 feet for easting and difference of latitude of the two Observatories ; using 79.03 feet for one second of arc in our parallel, and 101.82 for one second on our meridian, I get with sufficient accuracy 93 .03 for difference of longitude, and 47′.42 for difference of latitude, of the two domes.

This difference of latitude applied to the above gives, —

Latitude of Naval Observatory 38° 53′ 38″.58 by our observations.
" " " 38 53 39.23 by Lieut. Maury.

0.65 Difference.

Ten meridian observations of λ *Ursæ Minoris* with Nautical Almanac declinations gave 38° 54′ 26″, and about 180 of the Nautical Almanac stars 38° 54′ 25″.6, for the latitude of our Observatory.

From the office of the Surveyor of Washington, I find that the dome of the Capitol is south of the parallel of the dome of Naval Observatory by 1,906 feet, and eastward by 12,158$\frac{1}{12}$ feet. This makes 18″.71 difference of latitude, and 153″.85, or 10ˢ.26 in time, difference of longitude.

The difference of longitude of our Observatory from Greenwich depends upon only four complete observations of the moon and moon-culminating stars, which were observed here and at Greenwich on the seven wires of the instruments; and although it was the moon's first limb that was observed, I do not allow any thing for irradiation; as at the most there can be only the difference of irradiation of the Georgetown and Greenwich instruments and persons, which must be very little. There were other observations, but being imperfect either here or at Greenwich, they are not used, as I think there is sufficient reason to exclude every observation wherein the objects are not observed at all the wires (five or seven) of the instrument at both places.

Difference of longitude of Georgetown College Observatory and Greenwich, by,

1846.		h. m. s.
Feb. 4,	Moon's 1st limb and Aldebaran,	5 8 18.93
9,	29 Cancri, moon's 1st limb, and δ Cancri,	16.18
March 10,	o Leonis, moon's 1st limb, and Regulus,	17.80
Oct. 3,	ω Piscium, moon's 1st limb, and d Piscium,	19.70
	Mean, ...	5 8 18.15

By taking 5ʰ 8ᵐ 18ˢ.2 for longitude of our Observatory, we have 5ʰ 8ᵐ 12ˢ.0 for longitude of the Naval Observatory, 5ʰ 8ᵐ 01ˢ.74 for longitude of the dome of the Capitol, and for the latitude of the Capitol 38° 53′ 20″ (19″.87).

I thought it well to give the above, as you have a signal on our Observatory. I hope at some future time to obtain from you the distance of the two Observatories, when your triangles shall have been used and the sides computed.

I obtained also for

	Lat. ° ′ ″		Long. h. m. s.
President's house (center),	38 53 46.2	and	5 8 8.44
Meridian stone,	38 53 19.86	and	5 8 8.44
Smithsonian Institution (center),	38 53 16.13	and	5 8 5.92
Patent Office (center of present building),	38 53 46.15	and	5 8 5.19

JAMES CURLEY.

SUPPLEMENTARY NOTE ON AN ERROR IN THE GREENWICH PLANETARY REDUCTIONS.

Cambridge, May 9, 1850.

Dear Sir, — When I gave you the corrected intervals of the transit-wires for 1764, which have been published in the *Astronomical Journal*, I forgot to state at what time the change occurred.

On the 24th of September, 1763, Mr. Bliss observes, — "Before γ Aquilæ and the following stars passed, the end of the telescope received an accidental stroke," &c.

The same night, after the stroke, was observed, —

	h. m. s.	m. s.	m. s.	m. s.	m. s.
α Piscis Australis,	22 43 18.50	44 0.00	44 42.00	45 24.00	46 5.50
Wires reduced, with unchanged intervals,	44 41.70	41.79		42.30	42.34
" " " changed "	44 41.03	41.41		42.59	43.03

The intervals seem to have been altered but little by that stroke.

On the 5th of October, Mr. Bliss notices, before the observations, another stroke of the instrument. The following day was observed again: —

	h. m. s.	m. s.	m. s.	m. s.	m. s.
α Piscis Australis,	22 43 13.25	43 54.50	44 36.00	45 17.25	45 58.75
Wires reduced, with unchanged intervals,	44 36.45	36.29		35.55	35.59
" " " changed "	35.73	35.91		35.84	36.28

Here the alteration was caused, and the corrected intervals therefore are to be used from 1763, October 5, to the close of the observations by Mr. Bliss.

Very respectfully, your most obedient servant,

E. SCHUBERT.

Lieut. Charles Henry Davis, Superintendent Nautical Almanac.

EPHEMERIS OF NEPTUNE, 1850.

By SEARS C. WALKER, Esq.

From the "Smithsonian Contributions to Knowledge."

[Communicated by the author for the Astronomical Journal.]

Greenwich Mean Noon.	α ♆	δ ♆	Greenwich Mean Noon.	α ♆	δ ♆	Greenwich Mean Noon.	α ♆	δ ♆
1850.	° ′ ″	° ′ ″	1850.	° ′ ″	° ′ ″	1850.	° ′ ″	° ′ ″
June 2	339 2 27.85	—9 38 11.47	Aug. 12	338 9 58.05	—10 1 7.16	Sept. 28	337 0 2.66	—10 28 42.68
10	3 20.55	38 9.16	13	8 29.91	1 42.85	29	336 58 45.35	29 12.33
18	339 2 15.42	38 52.99	14	7 1.19	2 18.72	30	57 29.07	29 41.54
26	338 59 16.11	40 21.52	15	5 31.95	2 54.76	Oct. 1	56 13.87	30 10.30
30	57 5.17	41 21.79	16	4 2.24	3 30.95	2	54 59.80	30 38.59
July 1	56 28.31	41 38.48	17	2 32.10	4 7.29	3	53 46.96	31 6.41
2	55 49.80	41 55.80	18	338 1 1.54	4 43.77	4	52 35.27	31 33 75
3	55 9.66	42 13.76	19	337 59 30.56	5 20.35	5	51 24.75	32 0.60
4	54 27.90	42 32.34	20	57 59.18	5 57.03	6	50 15.42	32 26.94
5	53 44.51	42 51.55	21	56 27.43	6 33.81	7	49 7.36	32 52.78
6	52 59.51	43 11.37	22	54 55.37	7 10.67	8	48 0.62	33 18.09
7	52 12.92	43 31.78	23	53 23.05	7 47.59	9	46 55.23	33 42.84
8	51 24.75	43 52.78	24	51 50.49	8 24.56	10	45 51.22	34 7.04
9	50 35.03	44 14.36	25	50 17.75	9 1.56	11	44 48.57	34 30.68
10	49 43.80	44 36.51	26	48 44.88	9 38.58	12	43 47.31	34 53.75
11	48 51.08	44 59.23	27	47 11.92	10 15.61	13	42 47.48	35 16.23
12	47 56.88	45 22.51	28	45 38.89	10 52.64	14	41 49.11	35 38.13
13	47 1.25	45 46.35	29	44 5.80	11 29.65	15	40 52.21	35 59.43
14	46 4.19	46 10.75	30	42 32.67	12 6.64	16	39 56.79	36 20.12
15	45 5.73	46 35.68	31	40 59.52	12 43.59	17	39 2.88	36 40.19
16	44 5.90	47 1.12	Sept. 1	39 26.39	13 20.49	18	38 10.51	36 59.65
17	43 4.73	47 27.07	2	37 53.32	13 57.31	19	37 19.73	37 18.50
18	42 2.23	47 53.51	3	36 20.36	14 34.02	20	36 30.54	37 36.73
19	40 58.39	48 20.44	4	34 47.55	15 10.64	21	35 42.96	37 54.31
20	39 53.24	48 47.85	5	33 14.93	15 47.17	22	34 57.01	38 11.23
21	38 46.83	49 15.73	6	31 42.55	16 23.56	23	34 12.71	38 27.49
22	37 39.17	49 44.08	7	30 10.45	16 59.79	24	33 30.07	38 43.09
23	36 30.29	50 12.90	8	28 38.68	17 35.85	25	32 49.09	38 58.04
24	35 20.23	50 42.17	9	27 7.27	18 11.74	26	32 9.81	39 12.31
25	34 9 00	51 11.87	10	25 36.28	18 47.45	27	31 32.25	39 25.90
26	32 56.64	51 41.97	11	24 5.60	19 22.96	28	30 56.45	39 38.80
27	31 43.18	52 12.48	12	22 35.41	19 58.26	29	30 22.39	39 51.01
28	30 28.63	52 43.38	13	21 5.71	20 33.31	30	29 50.09	40 2.54
29	29 13.00	53 14.66	14	19 36.55	21 8.09	31	29 19.57	40 13.36
30	27 56.32	53 46.33	15	18 7.96	21 42.62	Nov. 1	28 50.82	40 23.47
31	26 38.63	54 18.37	16	16 39.97	22 16.89	2	28 23.88	40 32.86
Aug. 1	25 19.95	54 50.77	17	15 12.62	22 50.89	3	27 58.79	40 41.52
2	24 0.31	55 23.52	18	13 45.92	23 24.59	4	27 35.56	40 49.46
3	22 39.74	55 56.61	19	12 19.95	23 57.98	5	27 14.20	40 56.67
4	21 18.27	56 30.02	20	10 54.71	24 31.06	6	26 54.73	41 3.13
5	19 55.95	57 3.74	21	9 30.23	25 3.80	7	26 37.17	41 8.85
6	18 32.80	57 37.74	22	8 6.53	25 36.18	8	26 21.50	41 13.83
7	17 8.83	58 12.02	23	6 43.65	26 8.22	9	26 7.74	41 18.08
8	15 44.08	58 46.58	24	5 21.63	26 39.89	10	25 55.90	41 21.59
9	14 18.60	59 21.39	25	4 0 51	27 11.19	11	25 45.98	41 24.34
10	12 52.42	9 59 56.43	26	2 40.30	27 42.10	12	25 38.00	41 26.35
11	338 11 25.56	—10 0 31.68	27	337 1 20.99	—10 28 12 60	13	336 25 31.97	—10 41 27.62

(*To be completed in next No.*)

LAMONT'S OBSERVATIONS OF NEPTUNE.

THE Neptune observations discovered by Mr. HIND in LAMONT'S Zones (*Astr. Jour.*, p. 47) have been compared by Mr. WALKER with his elliptic elements, using Professor PEIRCE'S values for the perturbations. Mr. WALKER finds the following differences: —

Date.	Obs. — Eph. $\Delta\alpha$	Obs. — Eph. $\Delta\delta$
1845, Oct. 25	$+3''.40$	$+2''.38$
1846, Sept. 7	-6.91	$+6.26$

COMET.

PROFESSOR SCHUMACHER has issued the following circular: —

"On the 1st of May, at $10^{h.}$ M. T., Dr. PETERSEN at the Altona Observatory, discovered a faint telescopic comet whose estimated position was

$$\alpha = 19^{h.}\ 25^{m.} \qquad \delta = +71^\circ\ 10'$$

The unfavorable weather did not permit him to observe it.

"On the 2d of May it was seen again. The right-ascension appeared to have changed but slightly; the declination had become about 8′ more northerly. According to the hastily reduced observations, the position at $11^{h.}$ M. T. was

$$\alpha = 19^{h.}\ 24^{m.}\ 7^{s.}.9 \qquad \delta = +71^\circ\ 19'\ 34''$$

and the hourly change in $\alpha = -2^{s.}$, in $\delta = +20''$.

H. C. SCHUMACHER.

"*Altona*, May 3, 1850."

Dr. PETERSEN has also communicated to the editor the following observations: —

May 3, Altona M. T. $9^{h.}\ 52^{m.}\ 25^{s.}.3 \quad \delta = +71^\circ\ 28'\ 51''.2$; Daily proper motion in $\alpha = -1^{m.}\ 3^{s.}.3$
$10^{h.}\ 15^{m.}\ 42^{s.}.5 \quad \alpha = 19^{h.}\ 23^{m.}\ 6^{s.}.69$; " " " " $\delta = +9'\ 44''$

G.

NOTICE.

OWING to the difficulty which astronomers in this country have experienced in obtaining copies of the "*Ergänzungs-heft*," or supplementary volume to the *Astronomische Nachrichten*, lately published, Professor SCHUMACHER has forwarded to the editor a number of copies for disposal in the United States. They will probably arrive at an early date, and astronomers or libraries desiring the "*Ergänzungs-heft*" can then obtain them by application to the editor of this Journal. G.

CORRIGENDA.

Page 25, In the expression for $D_r r$, r^2 should be a factor of both terms.
" 64, Table I., cols. 2 and 3, *for* 1842, June 15, 16, and 21, *read* 1842, July 15, 16, and 21.

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ASTRONOMICAL JOURNAL.

No. 10.

VOL. I. CAMBRIDGE, JUNE 10, 1850. NO. 10.

EPHEMERIS OF NEPTUNE, 1850.

By SEARS C. WALKER, Esq.

(*Continued from page* 71.)

Greenwich Mean Noon.	α ♆	δ ♆	Greenwich Mean Noon.	α ♆	δ ♆	Greenwich Mean Noon.	α ♆	δ ♆
1850.	° ′ ″	° ′ ″	1850.	° ′ ″	° ′ ″	1850.	° ′ ″	° ′ ″
Nov. 14	336 25 27.86	—10 41 28.14	Dec. 1	336 29 16.80	—10 39 41.20	Dec. 18	336 42 23.29	—10 34 20.12
15	25 25.70	41 27.90	2	29 47.89	39 28.14	19	43 26.07	33 54.93
16	25 25.50	41 26.90	3	30 20.91	39 14.33	20	44 30.50	33 29.08
17	25 27.24	41 25.14	4	30 55.86	38 59.77	21	45 36.68	33 2.57
18	25 30.93	41 22.62	5	31 32.75	38 44.46	22	46 44.58	32 35.40
19	25 36.54	41 19.36	6	32 11.56	38 28.43	23	47 54.27	32 7.57
20	25 44.10	41 15.34	7	32 52.28	38 11.66	24	49 5.63	31 39.10
21	25 53.64	41 10.55	8	33 34.90	37 54.16	25	50 18.66	31 10.00
22	26 5.14	41 5.01	9	34 19.42	37 35.94	26	51 33.36	30 40.29
23	26 18.59	40 58.72	10	35 5.82	37 16.99	27	52 49.67	30 9.96
24	26 34.01	40 51.67	11	35 54.11	36 57.32	28	54 7.62	29 39.01
25	26 51.40	40 43.86	12	36 44.24	36 36.94	29	55 27.08	29 7.45
26	27 10.74	40 35.30	13	37 36.23	36 15.87	30	56 48.14	28 35.29
27	27 32.03	40 25.99	14	38 30.02	35 54.10	31	58 10.79	28 2.54
28	27 55.27	40 15.92	15	39 25.62	35 31.64	1851.		
29	28 20.49	40 5.10	16	40 23.06	35 8.49	Jan. 1	336 59 34.97	—10 27 29.17
30	336 28 47.67	—10 39 53.52	17	336 41 22.28	—10 34 44.65			

COÖRDINATES.

(x, y, *and* z *are referred to the Apparent Equinox and Equator.*)

1850.		r	x	y	z	Log. △
January	1	29.97053	+26.97693	—11.82129	—5.544177	1.4852562
	9	.97038	.98776	.80002	.535722	.4867189
	17	.97017	26.99856	.77872	.527269	.4879855
	25	.96996	27.00933	.75743	.518818	.4890324
February	2	.96976	.02008	.73614	.510366	.4898460
	10	.96955	.03081	.71486	.501916	.4904138
	18	.96934	.04151	.69358	.493467	.4907257
	26	.96913	.05219	.67230	.485018	.4907786
March	6	.96892	.06284	.65102	.476567	.4905744
	14	.96871	.07348	.62973	.468111	.4901181
	22	.96850	.08109	.60844	.459648	.4894156
	30	.96830	.09169	.58713	.451181	.4884792
April	7	29.96809	+27.10528	—11.56582	—5.442708	1.4873295

1850.		r	x	y	z	Log. △
April	15	29.96788	+27.11584	—11.54450	—5.431227	1.4859821
	23	.96767	.12637	.52317	.425740	.4844612
May	1	.96747	.13690	.50184	.417244	.4827933
	9	.96727	.14741	.48018	.408739	.4810050
	17	.96706	.15791	.45909	.400223	.4791266
	25	.96686	.16841	.43767	.391697	.4771922
June	2	.96666	.17889	.41624	.383162	.4752353
	10	.96645	.18935	.39480	.374623	.4732881
	18	.96625	.19980	.37335	.366081	.4713911
	26	.96605	.21023	.35190	.357537	.4695771
July	4	.96585	.22063	.33044	.348994	.4678793
	12	.96565	.23101	.30898	.340454	.4663326
	20	.96546	.24137	.28750	.331913	.4649689
	28	.96526	.25171	.26603	.323375	.4638154
August	5	.96506	.26203	.24453	.314838	.4628966
	13	.96486	.27233	.22304	.306300	.4622325
	21	.96466	.28260	.20156	.297762	.4618404
	29	.96446	.29284	.18009	.289223	.4617277
September	6	.96426	.30306	.15862	.280683	.4618990
	14	.96407	.31326	.13715	.272138	.4623539
	22	.96388	.32344	.11568	.263587	.4630824
	30	.96368	.33360	.09420	.255032	.4640698
October	8	.96349	.34374	.07271	.246471	.4652965
	16	.96330	.35387	.05120	.237904	.4667382
	24	.96310	.36399	.02969	.229329	.4683635
November	1	.96291	.37409	11.00817	.220744	.4701396
	9	.96272	.38418	10.98663	.212148	.4720315
	17	.96253	.39425	.96504	.203542	.4739974
	25	.96234	.40430	.94343	.194931	.4760012
December	3	.96215	.41434	.92181	.186315	.4780031
	11	.96196	.42437	.90019	.177693	.4799638
	19	.96178	.43439	.87855	.169067	.4818449
	27	.96159	.44440	.85690	.160442	.4836138
	35	29.96141	+27.45439	—10.83525	—5.151819	1.4852387

OBSERVATIONS OF ASTRÆA AND HYGEA,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant Maury, Director of the Observatory.

[Corrected for refraction.]

ASTRÆA.

Date.	M. T. Washington.	No. of Obs	Star of Comparison.	⯙ — *		⯙'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1850.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
Jan. 5	10 24 51.1	3	790, Weisse II.	+0 56.94	+ 1 26.29	2 40 46.41	+ 8 44 31.68
14	9 49 22.4	3	880, "	—0 33.78	— 8 18.78	2 49 45.39	+ 9 27 35.62
		3	893, "	—1 27.75	— 8 45.82	2 49 44.71	+ 9 27 36.82
Feb. 4	10 20 31.6	2	114, Weisse III.	—1 34.71	—14 8.33	3 5 8.49	+11 37 58.61
5	10 8 19.6	10	114, "	—0 35.64	— 7 19.77	3 6 7.54	+11 44 47.11

Date.	M. T. Washington.	No. of Obs.	Star of Comparison.	⚴ — *		⚴'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1850.	h. m. s.			m. s.	′ ″	h m. s	° ′ ″
Feb. 11	9 10 51.3	8	172, Weisse III.	+2 31.19	+11 33.49	3 12 31.90	+12 27 39.63
14	7 9 18.0	6	205, "	+4 17.84	— 0 52.68	15 53.64	12 48 41.85
16	8 48 28.0	5	306, "	+0 58.41	— 1 26.29	18 22.61	13 3 44.36
	10 13 31.0	5	306, "	+1 3.39	— 0 54.40	18 27.58	4 16.25
17	8 56 40.0	6	306, "	+2 12.13	+ 5 55.82	19 36.31	11 6.44
19	7 59 35.3	5	447, "	—2 57.35	+ 9 18.02	22 3.26	25 28.27
	9 59 48.5	3	447, "	—2 51 25	+ 9 53.50	22 9.36	26 3.76
22	7 17 13.6	6	474, "	—0 17.82	+ 7 22.70	25 55.86	47 22.94
	9 33 21.3	6	474, "	—0 10.70	+ 8 2.61	26 3.00	48 2.85
23	7 41 16.1	7	474, "	+1 3.42	+14 48.26	27 16.98	13 54 48.47
25	7 44 26.5	10	*k*	+1 52 05	+12 20.27	29 58.49	14 9 29.94
26	9 23 51.1	6	940, Rümker	—2 20.09	— 0 55.84	31 28.35	14 17 16.69
March 4	9 18 35.5	6	774, Weisse III.	—0 20.35	— 6 0.37	40 5.56	15 1 8.73
	9 38 17.3	5	774, "	. . . .	— 5 53.53	. . . .	1 15.56
5	7 51 44.6	3	774, "	+1 3.39	+ 0 48.28	41 29.30	7 57.34
10	8 12 33.9	6	*n*	+1 10.64	+ 0 46.52	48.6	42.8
	8 45 26.3	3	*n*	+1 12.93	+ 0 55.56	. . . .	. . . . . .
11	7 51 18.5	3	*m*	+2 50.59	+ 2 18.52	3 50.2	+15 50.5
	8 19 2.0	4	*m*	+2 53.32	+ 2 26.15	. . . .	. . . . . .

Adopted Mean Places for 1850.0 *of Comparison-Stars.*

*	Mag.	α	Ann. Prec.	δ	Ann. Prec.	Authority.	No. of Obs.
		h. m. s.		° ′ ″			
790, Weisse II.	8	2 45 43.33	+3.206	+ 8 43 12.78	+15.036	Weisse's Catalogue.	
880, "	8.9	2 50 19.11	3.224	9 36 0.29	14.786	" "	
893, "	8.9	2 51 12.45	3.224	9 36 28.55	14.714	" "	
114, Weisse III.	9	3 6 43.33	3 275	11 52 15.26	13.758	" "	
172, "	8	3 10 0.93	3.285	12 16 14.71	13 550	" "	
205, "	8	3 11 36.07	3.296	12 49 43.07	13.551	" "	
306, "	9	3 17 24.46	3.306	13 5 19.26	13 064	" "	
447, "	8	3 25 0.86	3.316	13 16 19.05	12.551	" "	
474, "	9	3 26 13.90	3.325	13 40 9.05	12.468	" "	
k	9	3 28 6.79	3.332	13 57 18.52	12.339	Wash'n Equatorial, from 474, Weisse III.	5
940, Rümker	9	3 33 48.83	3.343	14 18 21.38	11.942	Rümker's Catalogue.	
774, Weisse III.	9	3 40 26.23	+3.367	15 7 17.94	+11.472	Weisse's Catalogue.	
n	9	3 47.6		15 43.6			
m	9	3 47.4		+15 48.2			

HYGEA.

Date.	M. T. Washington.	No. of Obs.	Star of Comparison.	Hygea — Star.		Hygea's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
	h. m. s.			m. s.	′ ″	h. m. s	° ′ ″
May 18	14 49 34.81	2	*a*	+1 21.76	+25 02.97	19 44 48.608	—22 9 47.334
(1) 20	14 36 37.58	3	*c*	—0 51.76	— 0 42.15	44 51.275	8 9.975
21	14 22 2.01	5	*e*	—2 12.31	+13 53.66	44 49.374	7 28.066
(1) 23	13 6 21.68	2	*e*	—2 19.80	+15 11.44	44 42.017	6 10.116
		2	*c*	—1 0.85	+ 1 20.48	19 44 42.377	—22 6 7.866

(1) Bright moonlight, with light floating clouds.

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.	No. Obs
		h. m. s.	° ′ ″		
a	9.10	19 43 25.69	—22 35 0.17	Washington Equatorial, from 6850, B. A. C.	2
e	9.10	19 47 0.45	—22 21 31.86	" " " " "	6
c	10	19 45 41.87	—22 7 37.74	" " from *e*.	5

Comparison with an ephemeris computed from Hensel's Elements IV., *Astr. Nachr.*, No. 702.

	Calc. — Obs. α	Calc. — Obs. δ		Calc. — Obs. α	Calc. — Obs. δ
	m. s.	′ ″		m. s.	′ ″
May 18	—1 12.83	+4 44.2	May 21	—1 15.00	+4 57.27
20	—1 14.27	+4 52.53	23	—1 16.87	+4 59.01

FROM LETTERS OF PROFESSOR SCHUMACHER TO THE EDITOR.

Altona, May 10, 1850.

Dr. Petersen has made an accurate reduction of his observations. They are as follows: —

	M. T. Altona.	☄ α	☄ δ	Obs.
	h. m. s.	h. m. s.	° ′ ″	
May 2	9 48 22.4	19 24 10.56	+71 19 4.8	2
	12 12 8.3	24 1.32::	19 55.8	2*
	13 37 7.8	24 2.32	. . . . .	2
3	9 52 25.3	. . . . .	71 28 50.7	3
	10 15 47.3	19 23 6.78		

Sonntag has observed here, —

	h. m. s.	h. m. s.	° ′ ″	
May 4	12 54 43	19 21 45.23	71 40 4.0	5

Mr. Rümker has also observed the comet in Hamburg.

	M. T. Hamburg.	☄ α	☄ δ
	h. m. s.	° ′ ″	° ′ ″
May 2	10 20 36.0	291 2 15.0	71 18 55.8
3	10 37 3.7	290 47 30.5	29 13.9
4	12 15 48.9	290 28 25.2	40 13.6

The following approximate elements have been computed by my son, Richard Schumacher, from Petersen's observations of May 2 and 3, and a mean of the two above mentioned for May 4.

T	1850, June 8.2032 Berlin.
π	250° 21′ 13″
☊	75 22 52
i	57 46 50
Log. q	9.999264
	Motion direct.

These elements represent each of the three fundamental places within 1″ in longitude, and 2″ in latitude. . . . . .

* This observation was made for the declination alone, which is therefore very reliable.

Sonntag has computed elements, and the following ephemeris, for mean Berlin midnight: —

	☄ α	☄ δ	Log. r	Log. △	△
	° ′	° ′			
May 0	291 14	+71 1	0.0776	9.9121	0.817
4	290 27	71 40	.0647	.8744	.749
8	288 47	72 23	.0523	.8315	.678
12	286 9	73 12	.0408	.7822	.606
16	282 7	74 7	.0302	.7252	.531
20	275 47	75 8	.0208	.6578	.455
24	265 24	76 10	.0129	.5767	.377
28	247 34	76 43	.0065	.4763	.299
June 1	219 16	74 48	0.0021	.3483	.233
5	188 57	+64 53	9.9995	9.1832	0.152

Weyer has, from George Rümker's elements, which are based upon his father's three observations, computed an ephemeris not very different. . . . . .

Professor Encke has sent me, from Berlin, an observation by Dr. Galle.

	M. T. Berlin.	α	δ	Obs.
	h. m. s.	° ′ ″	° ′ ″	
May 5	10 42 56.4	290 9 44.4	+71 49 12.2	5

I add another observation of Dr. Petersen's, which was made only an hour ago, but has been reduced with all rigor.

		α	δ	Obs.
	h. m. s.	h. m. s	° ′ ″	
May 8	10 26 43.0	19 15 39.64	+72 18 42.2	4

This is all I have to communicate on the subject, and you have now all the data for computing very accurate elements immediately, and for deciding whether this very inconvenient proximity is confirmed.

Altona, May 15, 1850.

I must send you the following additional observations concerning the comet:—

Mr. Rümker has observed,—

	M. T. Hamburg. h. m. s.	☄ α	☄ δ
May 7	10 56 17.4	289° 20′ 28″.2	+72° 9′ 12″.0
" 8	10 13 50.8	288 55 29.8	72 18 43.6

From the observations of May 2 and May 8, at Hamburg, and of May 5, at Berlin, the following orbits have been calculated by George Rümker and Niebour.

	G. Rümker.		Niebour.
T	1850, July 15.78181 Greenwich		July 15.77996
π	270° 52′ 22″.9		270° 52′ 19″.7
☊	91 4 47.6		91 4 44.5
i	66 38 3		66 38 6.6
Log q	0.025409	Direct	0.0254131

Difference of the Middle Observation.	Difference of Middle Observation.
In long. +14″.5	In long. —2″.0
In latit. + 8.3	In latit. +8.3

You observe that these elements are totally different from the former, and much less startling as regards the distance of the comet. Important changes in the elements must still be expected; for the heliocentric latitudes are but slightly different, which makes the determination of ☊ and i uncertain.

Weyer has calculated from Niebour's elements the following ephemeris for mean Berlin midnight:—

	☄ α	☄ δ	Log. △
May 0	291° 27′	+70° 58′	0.1548
4	290 29	71 39	.1366
8	288 56	72 18	.1170
12	286 31	72 56	.0958
16	283 30	73 31	.0729
20	279 20	73 58	.0479
24	274 5	74 16	0.0209
28	267 40	+74 18	9.9912

Dr. Olde has computed an orbit from the observations at Altona, May 2 and May 8, and at Berlin, May 5.

T	1850, July 9.95900 Greenwich.	
π	268° 28′ 35″.7	M. equinox, May 1.
☊	89 29 41.0	M. equinox, May 1.
i	65 23 28.5	
Log q	0.0206016	
	Direct.	

The middle observation is represented as follows:—

Calc. — Obs.
Long. —6″.1 Lat. +5″.2

Sonntag has computed from these elements the place for May 28, mean Berlin midnight,

α	δ	Log. △
266° 38′	+74° 20′	9.9451

which agrees with Weyer within 1° in right-ascension. . . . . .

These are unquestionably the most reliable elements we have as yet.

Dr. Petersen has since obtained some excellent observations,—

	M. T. Altona. h. m. s.	☄ α h. m. s.	☄ δ ° ′ ″	Obs.
May 12	10 27 47.2	. . . .	+72 56 11.8	4
	10 32 58.7	19 6 36.26	. . . . .	7
May 13	11 13 50.4	19 3 46.13	+73 5 13.3	6
.	.	.	.	.

I have received in a letter from Mr. Sheepshanks the following notices, which I must add for your Journal.

Mr. Lassell observed, on March 27, with his twenty-foot reflector (twenty-four inches' aperture and a magnifying power of 430) four or five white spots in the belt directly above the middle belt on Jupiter's disc. I will give you the description in his own words:—

"The white spots are most remarkable. The principal spot is exactly half-way over at 11ʰ (Greenwich M. T.). They are all perfectly round, distinct, and bright. The largest is as plain as I have seen with the nine-foot telescope the disc of a satellite just entered within the limb, and as well defined. They are striking phenomena.—11ʰ 20ᵐ. The spots keep their relative positions as they are carried along by Jupiter's rotation; and there are no other similar spots anywhere on the disc. I tried 22 and 20 inches' aperture, but there was no improvement of definition."

Lassell has also made some more observations of the satellite of Neptune with his twenty-foot reflector (power of 366).

1849.	Greenwich M. T. h. m. s.	Position.	Distance.	Obs.
Nov. 11	6 56 40.7		17″.45	4
	7 31 58.0	219° 57′		5
Dec. 6	6 35 25.7	45 2		1

The distance was measured with difficulty on the 11th November. On the 6th December, sky was brilliant, but definition bad; no satisfactory measures of distance could be taken.

H. C. SCHUMACHER.

NOTE BY THE EDITOR.

In the Report to the Smithsonian Institution on the History of the Discovery of Neptune, after speaking of the numerous errors detected by Le Verrier in Bouvard's Tables of Uranus, I have stated (1) that "neither Airy had detected these errors, nor Bessel published any thing concerning them, excepting the notice of the one term already referred (2) to."

The Astronomer Royal has called my attention to this statement, and referred me to the volume of Reductions of the Greenwich Planetary Observations, the printing of which was finished (3) in May, 1845. In the beginning of this volume is a large catalogue of *Errata* in the various works used; and, among others, in Bouvard's Tables. Professor Airy informs me, as I find also by comparison, that almost every one of the typographical errors which Le Verrier found in these tables, and several more, are given in this list. (4) The inconsistency of the elliptic equation is also pointed out. My remark was based upon Professor Airy's statement (5) cited in the marginal reference, that he had satisfied himself that there was no error in the pure elliptic theory; and it gives me great pleasure to be able to make this correction.

The enormous list of errors in the standard tables and collections of observations used is no small contribution toward the advancement of astronomy; yet, when it is remembered that these are published together with the treasures contained in the remainder of the volume, the neglect to remember them in this connection may perhaps be deemed a pardonable oversight.

BENJ. APTHORP GOULD, Jr.

Cambridge, June 4, 1850.

OBSERVATIONS OF PETERSEN'S COMET MADE AT THE CAMBRIDGE OBSERVATORY.

1850, May 29, $11^{h.}\ 30^{m.}\ 7^{s.}$, Cambridge M. S. T.

☄'s R.A. $= 17^{h.}\ 46^{m.}\ 9^{s}.6$

Dec. $= 74°\ 12'\ 45''$

Compared with the star *a* of the 8.9 magnitude H. C. 32630.

May 29, $11^{h.}\ 52^{m.}\ 52^{s.}$

☄'s R.A. $= 17^{h.}\ 46^{m.}\ 3^{s}.8$

Dec. $= 74°\ 12'\ 30''$

Compared with the star *b* of the 7th magnitude B. A. C. 6001.

The last of these two positions is the best determined.

May 31. The comet visible this evening for a few minutes only, through the clouds. By the circles of the equatorial at $9^{h.}\ 30^{m.}$,

☄'s R.A. $= 17^{h.}\ 32^{m.}\ 52^{s.}$

Dec. $= 74°\ 3'$

A single comparison was made in declination with the micrometer with a star of the 9th magnitude, supposed to be H. C. 32630, at $9^{h.}\ 47^{m.}\ 53^{s.}$.

☄ south of ✱ $2'\ 7''.4$

Dec. $= 74°\ 3'\ 12''$

June 1, $9^{h.}\ 38^{m.}\ 51^{s.}$

☄ precedes ✱ *c*, $1^{m.}\ 2^{s}.60$

" north of " $2'\ 38''.7$

The approximate place of the star is, —

R.A. $= 17^{h.}\ 26^{m.}\ 44^{s.}$

Dec. $= 73°\ 53'\ 34''$

By the circles of the equatorial corrected by 24 Draconis, at $9^{h.}\ 56^{m.}\ 18^{s.}$,

☄'s R.A. $17^{h.}\ 25^{m.}\ 36^{s.}$

Dec. $73°\ 56'\ 6''$

June 3, $10^{h.}\ 5^{m.}\ 14^{s.}$

R.A. $= 17^{h.}\ 10^{m.}\ 44^{s}.1$

Dec. $= 73°\ 36'\ 18''$

By two comparisons with the star *d*, = Groombridge 2420. The place of the star was taken from the Radcliffe Observations for 1841 and 1842.

June 4, $11^{h.}\ 11^{m.}\ 35^{s.}$

R.A. $= 17^{h.}\ 2^{m.}\ 55^{s}.1$

Dec. $= 73°\ 22'\ 56''$

By three comparisons with the star *e*, = B. A. C. 5769.

June 4, $11^{h.}\ 11^{m.}\ 35^{s.}$

R.A. $= 17^{h.}\ 2^{m.}\ 54^{s}.9$

Dec. $= 73°\ 22'\ 53''$

By two comparisons with the star *f*, = Groombridge 2418. The star's place was taken from the Radcliffe Observations for 1842 and 1843.

The above positions are referred to the mean equinox of 1850.0.

The following are the places of the stars of comparison used in the reductions: —

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(1) *Report*, p. 27, line 2. (2) *Ibid.*, p. 10, line —10. (4) *Introd.*, p. liii. (5) Airy's "*Account*," &c., p. 126.

(3) See *Report to the Board of Visitors*, June, 1845.

	R. A. Jan. 1. h. m. s.	Dec. Jan. 1. ° ′ ″	
Star *a*	17 40 7.45	74 5 18.9	Argel. Zones, No. 129, H. C. 32630.
b	17 36 50.29	74 19 1.9	B. A. C. 6001 = 29 Draconis.
c	17 26 44	73 53 34	Approximate.
d	17 4 29.87	73 31 5.0	Groombridge 2420.
e	16 59 17.55	73 21 10.2	B. A. C. 5769.
f	17 3 34.21	73 24 12.0	Groombridge 2418.

From the places on May 29, June 1 and 3, Mr. G. P. Bond finds the following for the elements of the orbit: —

Perihelion Passage, July 20d.9167 Gr. M. S. T.

Longitude of Perihelion, 272° 58′ 47″

Longitude of Node, 93 5 32

Inclination, 67° 18′ 12″

Log. Perihelion Distance, 0.03165

Motion Direct.

These, having been derived from a heliocentric arc of less than four degrees, are not probably very accurate.

WILLIAM C. BOND.

Observatory, Cambridge, June 5, 1850.

SOUTHERN COMET OF NOVEMBER, 1849.

Lieutenant Maury, Superintendent of the Washington Observatory, has kindly forwarded to the editor a letter from Rev. Professor Curley of Georgetown, inclosing another from Captain Roger Horner of the ship Maryland, dated Philadelphia, May 29, 1850. It was from this ship on her passage to Rio de Janeiro, that Rev. Mr. Jenkins of Georgetown College saw a comet in the west, November 15, 1849, — accounts of which have already been published. Mr. Jenkins died at Rio, April 11, 1850, a martyr to his philanthropy, and Captain Horner now furnishes all the data within his reach, correcting, at the same time, a mistake in the previous accounts. The following is from his letter: —

"It was on November 15, sea account. The true time of the ship was 7h. 30m. P. M. Latitude 13° 32′ south, and longitude 34° 50′ west of Greenwich. Its bearing from the ship was west-northwest; its course was southeast and northwest; height of head from the horizon, 48°; in sight about one hour."

G.

LETTER FROM LIEUTENANT MAURY TO THE EDITOR.

National Observatory, Washington, June 6, 1850.

I send you Mr. Ferguson's observations of Petersen's comet, June 3, 4, and 5, with the equatorial.

The comet was readily found by an ephemeris, computed from Olde's elements, which you had the kindness to send me.

The position of the star of comparison, June 2, has not yet been determined. The position of the star of comparison, June 3, was determined by Professors Hubbard and Major, with the mural and meridian circles.

The comet shows a pearly white circular nebula, of about 1′ 30″ diameter, condensed at the center.

M. F. MAURY.

PETERSEN'S COMET.

Date.	M. T. Washington	No. of Obs	Comparison-Star.	☄ — * Δα	☄ — * Δδ	☄'s App. α	☄'s App. δ
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
June 2	10 35 38					17 16 19	+73 46 57
	11 57 44					15 52	46 46
3	10 15 58.7	5	Groomb. 2418	+7 0.86	+11 45.85	10 38.726	36 0.35
		5	2420	+6 5 57	+ 4 57.32	10 38.81	36 5.32
4	9 59 45.4	10	2411*	+3 52.81	+ 2 12.00	17 3 14.127	23 27.99
5	10 16 45.1	10	"	3 49.28	—12 51.61	16 55 34.162	+73 8 24.695

Apparent Places of Comparison-Stars.

		h. m. s.	° ′ ″
2418 Groomb.	June 3	17 3 37.86	+73 24 16.78
2420 Groomb.	3	17 4 33.24	73 31 6.89
2411 Groomb.	4	16 59 21.322	+73 21 15.99

The place of 2411 Groombridge is from the Radcliffe Observations of 2418 and 2420, from one observation of the meridian circle, and one of the mural circle. The observations are not corrected for refraction.

ON THE FIFTH COMET OF THE YEAR 1847.

By B. A. GOULD, Jr.

§ 1.

This comet was discovered 1847, July 20, by Brorsen at the Altona Observatory, (1) and was visible until Sept. 12, at which time the last observation (2) of it was made by Mr. Rümker, the director of the Observatory at Hamburg. It is described as having been very faint throughout the whole period of its apparition. Parabolic orbits were calculated by various computers; (3) but no elements were found capable of representing the course of the comet in a manner at all satisfactory, so that Professor Schumacher stated (4) at the time, that none of the recent comets had caused the calculators so much trouble in determining its orbit as this. Elliptic elements were subsequently published by Quirling and Niebour, (5) and by D'Arrest; (1) but these two orbits did not accord well with one another. The elements of D'Arrest were based upon observations up to August 17, and though, like all the results of that accomplished computer, they represented the observed places up to the time of calculation with great precision, yet they failed to represent the subsequent course of the comet. I am not aware that any later investigations concerning this comet have been published; and the interest which it appeared to possess from the fact that no satisfactory elements had been found, induced me, during the last summer, to make some calculations on the subject. Their completion was long delayed by a variety of untoward circumstances, and not a little by apparent analytical difficulties in the problem itself, — to which I hope to allude, in their proper connection, at some early period.

(1) *Astr. Nachr.*, XXVI. p. 87. (2) *Ibid.*, p. 200.
(3) Brorsen, Niebour, Powalry, Quirling, *Astr. Nachr.*, XXVI. p. 155; Schmidt, *Ibid.*, p. 179.
(4) *Ibid.*, p. 154. (5) *Ibid.*, p. 185.

(1) *Ibid.*, p. 192.

(To be continued.)

NOTICE.

Owing to the difficulty which astronomers in this country have experienced in obtaining copies of the "*Ergänzungs-heft*," or supplementary volume to the *Astronomische Nachrichten*, lately published, Professor Schumacher has forwarded to the editor a number of copies for disposal in the United States. They will probably arrive at an early date, and astronomers or libraries desiring the "*Ergänzungs-heft*" can then obtain them by application to the editor of this Journal. G.

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THE

ASTRONOMICAL JOURNAL.

No. 11.

VOL. I. CAMBRIDGE, JUNE 27, 1850. NO. 11.

ON THE FIFTH COMET OF THE YEAR 1847.

By B. A. GOULD, Jr.

(*Continued from page* 80.)

§ 2.

Observations.

The following are all the observations with which I am acquainted. They are here collected in the form in which they were originally published, — being referred to the apparent equinox at the time of observation, and given in the mean time of the place, with the exception of Mr. Hind's observations, which are given in Greenwich mean time.

ALTONA. (1)

1847. Date.		☄ α	☄ δ	Obs.	Stars.	Apparent Places of Comparison-Stars.		
							∗ α	∗ δ
	h m s	° ′ ″	° ′ ″				h. m. s	° ′ ″
July 21	12 38 7.7	29 4 27.5		3	a, b	a	1 54 52.65	+26 44 42.7
	12 45 31.6		+27 1 22.6	2	b	b	1 58 39.98	26 30 23.3
	13 26 11.3	29 8 5.3	27 2 54.7	2	a, c	c	1 57 54.29	27 6 2.0
25	13 4 53.7	36 53 18.5		7	d, e, f	d	2 24 32.06	30 43 53.6
	13 20 31.8		+31 3 25.6	4	d, e, f	e	2 24 57.49	30 43 40.6
						f	2 27 39 34	+30 56 10 5

The comet was exceedingly faint at the last two comparisons on July 21, and at all those on July 25, and only perceptible by dint of the greatest exertion when it passed the edges of the micrometer-ring.

HAMBURG. (2)

Date.		☄ α	☄ δ	Obs.
	h. m. s	° ′ ″	° ′ ″	
July 24	13 25 12.1	34 50 11.6	+30 4 0.2	3
25	13 40 9.1	36 55 46.2	31 4 12.0	6
26	14 7 33.4	39 9 29.5	32 4 41.0	
Aug. 1	13 16 18.4	54 23 5.1	37 28 45.2	7
2	12 11 49.1	57 9 17.8	38 11 37.1	11
3	12 39 35.0	60 12 10.0	38 52 56.0	8
4	11 56 36.9	63 10 18.2	39 28 4.8	4
6	12 23 31.0	69 33 8.4	40 26 47.5	7
7	14 15 30.6	73 1 49 0	40 49 7.7	
8	12 25 33.5	76 2 31.2::	41 3 2.8	
9	12 20 46 6	79 16 16.9	41 12 46.8	
10	12 24 18.6	82 30 57.0	41 16 51.6	
11	12 5 14.4	85 41 27.7	41 15 15.3	
12	13 21 29.0	89 2 15.5	+41 7 59.9	
Aug. 13	13 17 7.5	92 8 37.1	+40 55 26.4	
14	13 16 42.0	95 11 32.5	40 38 3.6	
15	15 7 25.8	98 23 22.9	40 14 23.1	
16	13 50 40.5	101 7 5.7	39 49 25.1	
17	13 51 55.7	103 54 37.5	39 19 23.3	
18	13 13 46.2	106 31 46.5	38 46 43.0	
19	13 33 7.8	109 10 16.7	38 9 25.0	
20	13 33 45.7	111 40 42.0	37 29 48.9	
21	13 41 39.2	114 5 30.9	36 47 32.4	
23	15 35 58.1	118 48 25.3	35 13 47.7	
26	13 51 39.2	124 48 26.7	32 49 35.5	
Sept. 4	15 58 59.0	140 0 27.0	24 34 51.6	7
5	15 49 38.2	141 26 44.4	23 38 36.3	5
12	16 8 22.4	150 48 53.4	+16 58 18.1	4

(1) *Astr. Nachr.*, XXVI. p. 95.

(2) *Ibid.*, XXVI pp. 96, 127, 182, 200.

LONDON. (1)

Date. M. T. Greenwich.	☄ α	☄ δ	Comp.-Star.	Δα ☄—*	Δδ ☄—*
h. m. s.	° ′ ″	° ′ ″		m. s.	′ ″
July 26 12 31 40	39 5 37.8	+32 3 24.0	H. C.	+0 27.15	—2 50.7
27 13 30 6	41 13 17.0	33 1 48.2	a	—0 39.83	+1 53 3
29 12 13 4	46 6 21.5	34 52 47.1	b	—0 15.13	+7 24 5
Aug. 3 11 30 10	60 8 25.2	38 52 7.8	*a*	+6 23.1	+3 19.0
7 15 7 28	73 13 56.0	40 50 18.1			
9 13 16 43	79 29 11.3	+41 13 16.4			

Mr. Hind says, — "I obtained the position of the star **b**, by comparing it with one of the 8th magnitude in the *Histoire Céleste*. Its apparent place was thus found to be

$$\alpha = 3^{h.}\ 4^{m.}\ 40^{s.}.56\ ; \quad \delta = +34^\circ\ 45'\ 22''.6.$$

The position of **a**, similarly deduced, is,

$$\alpha = 2^{h.}\ 45^{m.}\ 32^{s.}.96\ ; \quad \delta = +32^\circ\ 59'\ 54''.9.$$

The observations were all considered very good, notwithstanding the extreme faintness of the comet."

The position for August 3 is deduced from the star *a*, which is in Bessel's Zones, and for which Mr. Rümker found the apparent position August 3,

$$\alpha = 4^{h.}\ 0^{m.}\ 8^{s.}.14\ ; \quad \delta = +38^\circ\ 48'\ 48''.8.$$

KÖNIGSBERG. (2)

Date.	☄ α	☄ δ	Δα ☄—*	Δδ ☄—*	Mean Place of Comparison-Star, 1847.0. * α	* δ	Authority.
h. m. s.	° ′ ″	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	
July 26 13 8 3	38 47	+32 1			Middle of	the Field.	
Aug. 1 13 12 29	54 17 34.2	37 27 24.0	—12 51.0	—24 13.4	54 29 48.6	+37 51 44.1	B. Z., 448.
2 12 18 6	57 2 20.6	38 10 30.4	— 0 37.1	—13 4.9	57 2 21.4	38 23 42.8	H. C., p. 123.
7 12 11 8	72 38 54.1	40 47 5.0	—18 30.7	— 3 29.7	72 56 51.8	40 50 45.9	Piazzi, IV. 262.
11 11 51 10	85 34 11.9	41 15 31.2	—43 4.0	— 1 38.3	86 16 46.8	41 17 22.6	Groomb., 1037.
13 11 14 17	91 47 13.2	40 57 4.4	+ 8 56.5	+ 1 23.1	91 37 49.1	40 55 54.9	B. Z., 509, 516, 522.
18 14 15 40			—14 50.0	—22 13.3	106 49 —	39 8 —	
19 11 40 38	108 53 44.8	38 13 35.7	— 3 53.0	+ 6 34.4	108 57 15.5	38 7 15.7	H. C., p. 209.
22 14 2 20	116 22 34.0	+36 4 13.0	— 3 11.5	+15 49.3	116 25 25.0	+35 48 38.1	B. Z., 451.

BONN. (3)

Date.	☄ α	☄ δ	Obs.	Apparent Places of Comparison-Stars. α	δ	Authority.
h. m. s.	° ′ ″	° ′ ″		h. m. s.	° ′ ″	
Aug. 5 12 46 17	66 26 3.1	+40 1 3.8				
7 12 8 54	72 45 54.7	40 47 34.4				
11 11 56 12.0	85 41 51.2	41 15 9.7	6	5 41 56.55	+40 56 27.7	B. Z., 516.
12 12 10 23.9	88 54 25.2	41 9 9.8	6	5 53 20.31	41 10 55.0	" 509, 522.
13 12 30 18.5	92 4 15.5	40 56 36.8	5	6 6 33.66	40 56 39.2	" 509, 516, 522.
14 14 58 10.0	95 26 2.2	40 36 23.3	4	6 21 26.85	40 31 36.0	" 509.
15 14 55 28.1	*+1m. 18s..39	* + 25.96	6			
16 14 4 29.3	101 9 41.9	39 48 56 5	4	6 54 15.51	39 44 6.8	Ring-micrometer.
17 14 24 21.5	103 59 40 2	39 18 14.6	4	6 59 33.28	39 18 15.5	B. Z., 509.
18 14 32 59.5	106 42 18.0	+38 44 17.2	6	7 6 24.96	+38 58 25.2	" 490.

Mr. Schmidt, the observer at Bonn, states that he found that the comet grew brighter during August, and that the tail, the first indication of which he observed August 12, became by the 17th at least 15′ long.

BERLIN. (4)

Date.	☄ α	☄ δ	Date.	☄ α	☄ δ
h. m. s.	° ′ ″	° ′ ″	h. m. s.	° ′ ″	° ′ ″
Aug. 6 11 9 12.4	69 20 51.0	+40 25 26.5	Aug. 17 13 14 58.8	103 48 44.6	+39 20 20.3

(1) *Astr. Nachr.*, XXVI. pp. 143, 175. (2) *Ibid.*, XXVI. p. 149; XXVII. p. 7. (3) *Ibid.*, XXVI. p. 179. (4) *Ibid.*, XXVI. pp. 148, 176.

PARIS. (1)

Date.		☄ α	☄ δ	Places of Comparison-Stars. ✱ α	✱ δ
	h. m. s.				
Aug. 9	13 48 53.5	79° 32′ 12″.5	+41° 13′ 20″.5	80° 0′ 37″.8	+41° 19′ 59″.3
10	14 29 33.0	82 52 15.1	41 16 56.4	82 5 37.4	41 15 47.7
11	15 21 12.1	86 11 48.0	+41 14 37.0	86 17 18.7	+41 17 8.9

The comparison-star on the 10th was taken from Bessel's Zones, Nos. 516, 519, 522, and the two others were compared with this in right ascension and declination by means of the equatorial.

(1) *Comptes Rendus*, XXV. p. 265.

§ 3.

Approximate Ellipses.

In order to construct from these observations some normal places, from which elements might be deduced with comparative security, I computed ephemerides from each of the elliptic orbits already mentioned; but after due comparison, it seemed more advisable to commence the work anew, and I therefore drew an ellipse through the extreme observed positions, and one midway between them, — July 21, August 16, and September 12; and made use of the ephemeris thus obtained, to correct for parallax and aberration. This enabled me to construct normal places with care for the same dates, which furnished

Elements II.

Mean equinox 1847.0. — Berlin Mean Time.

T	1847, Sept. 9.58905.
☊	309° 48′ 2″.6
i	19 7 56.4
ω	129 22 30.7
ϕ	76 19 44.2
μ	49″.6367

Hence, we deduce the following expressions for the coördinates with reference to the equator: —

A. Apparent equinox of 1847, July 19.

$$x = [9.9857792].\,r.\,\sin\,(v + 170^\circ\,47'\,31''.3) = [0.6735564]\,\sin\,(E + 145^\circ\,33'\,15''.5) - 2.5918096$$
$$y = [9.9152103].\,r.\,\sin\,(v + 70\;26\;\;1.2) = [1.1270412]\,\sin\,(E + 85\;11\;53.7) - 12.972763$$
$$z = [9.7936606].\,r.\,\sin\,(v + 99\;55\;\;8.5) = [1.0236263]\,\sin\,(E + 92\;22\;\;0.1) - 10.251181$$

B. Apparent equinox of 1847, September 21.

$$x = [9.9857802].\,r.\,\sin\,(v + 170^\circ\,47'\,40''.3) = [0.6735224]\,\sin\,(E + 145^\circ\,33'\,41''.9) - 2.5911230$$
$$y = [9.9152055].\,r.\,\sin\,(v + 70\;26\;10.3) = [1.1270428]\,\sin\,(E + 85\;11\;56.1) - 12.972824$$
$$z = [9.7936661].\,r.\,\sin\,(v + 99\;55\;13.1) = [1.0236302]\,\sin\,(E + 92\;22\;\;1.2) - 10\,251271$$

(*To be continued.*)

FIRST COMET OF 1850.

The following parabolic elements of this comet have been computed at Washington by Professor Hubbard, from the observations at Hamburg, May 3 and 8, and Altona, May 13. They are referred to the apparent equinox of the middle observation.

T	1850, July 25.44942 M. T. Berlin.
n	93° 10′ 16″
ω	180 43 47
i	68 35 52
Log. q	0.03617

This orbit represents the second observation thus,

Calc. — Obs.

$\Delta\lambda$	$\Delta\beta$
−11″	+5″

The following ephemeris is based upon these elements, and may be of use. The epoch is Berlin mean midnight.

	α	δ	Log. Δ
	h. m. s.	° ′	
June 1.5	17 27 37	+73 43.8	0.02466
3.5	17 13 5	73 32.3	
5.5	16 58 15	+73 12.0	0.00182

	α	δ	Log. △
	h. m. s.	° ′	
June 7.5	16 43 10	+72 40.1	
9.5	28 9	71 56.9	9.97194
11.5	16 13 28	71 1.2	
13.5	15 59 20	69 51.1	9.93779
15.5	45 45	68 37.0	
17.5	32 52	67 7.6	9.90240
19.5	20 49	65 24.2	
21.5	15 9 35	63 25.9	9.86498
23.5	14 59 12	+61 11.8	
June 25.5	14 49 38	+58 40.6	9.82612
27.5	40 49	55 50.9	
29.5	14 32 47	+52 41.9	9.78711

Professor HUBBARD finds the observed corrections of ephemeris to be, —

	$\Delta\alpha$	$\Delta\delta$
	m. s.	′
June 3	—1 10	+5.1
4	—1 16	+1.6
5	—1 23	—1.3

ON THE EMPLOYMENT OF THE THEOREM, "SMALL ANGLES ARE PROPORTIONAL TO THEIR SINES."

BY WILLIAM CHAUVENET,

PROFESSOR OF MATHEMATICS IN THE U. S. NAVAL ACADEMY.

1. WHEN φ is to be computed by the equation $\sin\varphi = m\sin\alpha$, for given values of m and α, in what cases may we substitute the equation $\varphi = m\,\alpha$? That is, in what cases may we assume that the angles φ and α are proportional to their sines?

The practical limits are usually vaguely stated, as, for example, that "the angles may be as large as two degrees, provided the approximations are not carried beyond five places of decimals" (in the logarithms); and in this statement it is assumed that both the given and the computed angles are subject to the same limitations. I have thought that a more precise statement of the limits, in a tabular form, would be found useful in many cases where it is desirable to estimate the degree of accuracy of a particular computation; and have accordingly constructed the table given below. The nature and use of this table will be best explained by discussing the formulas by which it was computed.

2. The limits to be attached to α and m depend upon the degree of accuracy required in φ. In substituting $\varphi = m\,\alpha$ for $\sin\varphi = m\sin\alpha$, we neglect the third and higher powers of φ and α, in the developments of $\sin\varphi$ and $\sin\alpha$ in series. For the purposes of the present discussion, it will suffice to retain only the third powers of φ and α, and to consider as complete the equation,

$$\varphi - \frac{\varphi^3}{6} = m\left(\alpha - \frac{\alpha^3}{6}\right)$$

whence, still retaining only the third power of α,

$$\varphi = m\,\alpha - \frac{m\,(1-m^2)}{6}\,\alpha^3.$$

The error in computing φ by the equation $\varphi = m\,\alpha$, instead of $\sin\varphi = m\sin\alpha$, is therefore,

$$\Delta\varphi \doteq \frac{m\,(1-m^2)}{6}\,\alpha^3. \quad (1)$$

3. For a given value of α, $\Delta\varphi$ has a maximum for a value of m between 0 and 1; and putting the first differential coefficient of $\Delta\varphi$ equal to zero, we find

$$m = \sqrt{\tfrac{1}{3}}$$

whence the maximum error in φ is computed by the formula,

$$\Delta\varphi = \frac{\alpha^3}{\sqrt{243}} \quad (2)$$

or, for greater convenience in computation, expressing α in minutes, and $\Delta\varphi$ in seconds,

$$\Delta\varphi = \frac{(60\,\alpha)^3\sin^2 1''}{\sqrt{243}} = [3.51280]\,\alpha^3$$

e. g. if $\alpha = 60'$, this formula gives $\Delta\varphi = 0''.07$; that is, when $\alpha < 60'$ and $m < 1$, the error in computing φ by the equation $\varphi = m\,\alpha$, instead of $\sin\varphi = m\sin\alpha$, is less than $0''.07$.

If a maximum error $\Delta\varphi$ is assigned, and it is proposed to find the limit of α, we have, by inverting the preceding formula,

$$\alpha = \sqrt[6]{243}\times\sqrt[3]{\Delta\varphi} \quad (3)$$

or in minutes, $\Delta\varphi$ being in seconds,

$$\alpha = [2.16240]\,\sqrt[3]{\Delta\varphi}$$

e. g. it being proposed to find φ within $0''.1$, by putting $\Delta\varphi = 0''.1$ in this equation, we find that α must not exceed $1°\ 7'\ 28''$, m being less than unity.

4. But since $\Delta\varphi$ vanishes for $m = 1$, it will be less than the maximum above determined, even for values of m greater than unity, up to a certain limit, which we are next to find. The equation (1) may be written,

$$m^3 - m + \frac{6\,\Delta\varphi}{\alpha^3} = 0.$$

If we substitute the value of $\Delta\varphi$ given by (2), one root of the equation,

$$m^3 - m + \frac{2}{3\sqrt{3}} = 0$$

will be the above maximum of m, namely, $m = \sqrt{\frac{1}{3}}$; and depressing the equation by means of this root, we have,

$$m^2 + m\sqrt{\tfrac{1}{3}} - \tfrac{2}{3} = 0$$

the roots of which are $\sqrt{\frac{1}{3}}$ and $-2\sqrt{\frac{1}{3}}$, the second of which gives the superior limit of m required. It here appears with the negative sign, because $\Delta\varphi$ passes through the value zero

when m passes through the value unity; but as the present discussion obviously does not require us to distinguish the case where m is negative, we take as the superior limit,

$$m = 2\sqrt{\tfrac{1}{3}} = 1.1547. \qquad (4)$$

Hence, the last example of the preceding paragraph will be more completely stated thus: It being proposed to determine φ within 0″.1, we may employ the equation $\varphi = m\,\alpha$, instead of $\sin\varphi = m \sin\alpha$, provided α does not exceed 1° 7′ 28″; and if $\alpha =$ 1° 7′ 29″, m must not exceed 1.1547.

5. I pass now to the more general form of the problem, and to the construction of the table. A certain degree of accuracy in φ being assigned (expressed by $\Delta\varphi$), the given value of α may be greater or less than that which is found by the equation (3), and it is then required to determine the limits of m. It becomes necessary to solve the equation,

$$m^3 - m + \frac{6\,\Delta\varphi}{\alpha^3} = 0$$

without eliminating $\Delta\varphi$ and α, as was done above.

First, when $\alpha^3 < \Delta\varphi\sqrt{243}$, the equation has but one real root, which will be found most conveniently by the trigonometric method, thus (1): —

$$\left.\begin{aligned} \sin\ \vartheta &= \frac{\alpha^3}{\Delta\varphi}\sqrt{\frac{1}{243}} = [3\ 51280]\ \frac{\alpha^3}{\Delta\varphi} \\ \tan\tfrac{1}{2}\vartheta' &= \sqrt[3]{\tan\tfrac{1}{2}\vartheta} \\ m &= \frac{2}{\sin\vartheta'}\sqrt{\tfrac{1}{3}} = [0.06247]\ \text{cosec}\ \vartheta' \end{aligned}\right\} \qquad (5)$$

where the constant factors are given in logarithms, and as before α is supposed to be expressed in minutes, and $\Delta\varphi$ in seconds; the sign of the root has also been changed, for the reasons above given.

For a given value of $\Delta\varphi$, and any given value of α less than $\sqrt[3]{\Delta\varphi} \times \sqrt[6]{243}$, m may have any value between 0 and the limit given by these formulas.

Secondly, when $\alpha^3 > \Delta\varphi\sqrt{243}$, the equation has three real roots, which will be found by the formulas (2): —

$$\left.\begin{aligned} \sin\vartheta &= \frac{\Delta\varphi}{\alpha^3}\sqrt{243} = [6.48720]\ \frac{\Delta\varphi}{\alpha^3} \\ m_1 &= 2\sqrt{\tfrac{1}{3}}\sin\tfrac{1}{3}\vartheta = [0.06247]\sin\tfrac{1}{3}\vartheta \\ m_2 &= 2\sqrt{\tfrac{1}{3}}\sin(60° - \tfrac{1}{3}\vartheta) = [0.06247]\sin(60° - \tfrac{1}{3}\vartheta) \\ m_3 &= 2\sqrt{\tfrac{1}{3}}\sin(60° + \tfrac{1}{3}\vartheta) = [0.06247]\sin(60° + \tfrac{1}{3}\vartheta) \end{aligned}\right\} \quad (6)$$

where the roots are all taken with the positive sign only. Of these roots it is evident that m_1 and m_2 are always less than unity, and m_3 always greater than unity; and we shall obtain from them two sets of limits of m. We have seen that, for a given value of α, $\Delta\varphi$ has a maximum for $m = \sqrt{\tfrac{1}{3}}$, which obviously falls between m_1 and m_2. It is evident, then, that for the given values of $\Delta\varphi$ and α, m may have any value between 0 and m_1, or between m_2 and m_3; while any value of m between m_1 and m_2 will give a value of $\Delta\varphi$ greater than the given limit.

By these simple formulas I have prepared the following table, which is sufficiently extended to meet most of the cases in which it can be desirable to apply the principle that small angles are proportional to their sines. It appears to me that a table of this kind, perhaps more extended, would be a useful appendage to the common trigonometric tables.

*Table of Limits under which the Equation $\varphi = m\,\alpha$ may be employed instead of $\sin\varphi = m\sin\alpha$; α and m being given, to find φ within a given quantity $\Delta\varphi$.**

$\Delta\varphi <$ 1″	$\alpha <$ 0° 30′			$m <$ 3.6188
	1 0			1.9507
	1 30			1.4543
	2 0			1.2448
	(2° 25′ 20″)			1.1547
	2 30	$m <$ 0.4293	$m >$ 0.7137 and	$<$ 1.1430
	3 0	0.2122	0.8769	1.0891
	3 30	0.1298	0.9288	1.0586
	4 0	0.0861	0.9542	1.0403
	4 30	0.0603	0.9685	1.0288
	5 0	0.0439	0.9773	1.0212
$\Delta\varphi <$ 0″.1	$\alpha <$ 0° 10′			$m <$ 4.9753
	20			2.5894
	30			1.8387
	40			1.4951
	50			1.3118
	1 0			1.2057
	(1° 7′ 28″)			1.1547
	1 10	$m <$ 0.4171	$m >$ 0.7239 and	$<$ 1.1410
	20	0.2456	0.8543	1.0999
	30	0.1667	0.9061	1.0729
	40	0.1199	0.9347	1.0546
	50	0.0895	0.9522	1.0417
	2 0	0 0687	0.9639	1.0326

$\Delta\varphi <$ 0″.01	$\alpha <$ 0° 5′			$m <$ 4.6287
	10			2.4240
	15			1.7367
	20			1.4267
	25			1.2642
	30			1.1720
	(0° 31′ 19″)			1.1547
	35	$m <$ 0.3036	$m >$ 0.8130 and	$<$ 1.1166
	40	0.1917	0.8903	1.0820
	45	0.1320	0.9274	1.0594
	50	0.0954	0.9489	1.0443
	55	0.0714	0.9624	1.0338
	1 0	0.0549	0.9714	1.0263
$\Delta\varphi <$ 0″.001	$\alpha <$ 0° 3′			$m <$ 3.6188
	6			1.9507
	9			1.4543
	12			1.2448
	(0° 14′ 32″)			1.1547
	15	$m <$ 0.4293	$m >$ 0.7137 and	$<$ 1.1430
	18	0.2122	0.8769	1.0891
	21	0.1298	0.9288	1.0586
	24	0.0861	0.9542	1.0403
	27	0.0603	0.9685	1.0288
	30	0.0439	0 9773	1.0212

(1) CHAUVENET's *Pl. and Sph. Trigonometry*, p. 98.

(2) *Ibid*, p. 99.

* The numbers in parentheses are the values of α which satisfy the equation $\alpha^3 = \Delta\varphi\sqrt{243}$, and are the greatest values of α for which a single limit of m can be assigned.

6. A discussion similar to the above applies to the exchange of the equation $\tan \varphi = m \tan \alpha$, for the equation $\varphi = m\,\alpha$; for denoting by $\Delta'\varphi$ the error in φ computed by the latter, we shall find,

$$\Delta\ \varphi = \frac{m\,(1-m^2)}{3}\,\alpha^3$$

which is simply equal to $2\,\Delta\,\varphi$. Hence the preceding table may be used for finding the limits under which the angles may be exchanged for their tangents, by merely doubling the limits of $\Delta\,\varphi$ in the first column.

If, however, it is desired to compute directly the limits of m for given values of $\Delta'\varphi$ and α, our formulas become,

First, when $\alpha^3 < \frac{\Delta'\varphi\,\sqrt{243}}{2}$;

$$\left.\begin{aligned} \sin\,\vartheta &= [3.81383]\,\frac{\alpha^3}{\Delta'\,\varphi} \\ \tan\tfrac{1}{2}\vartheta' &= \sqrt[3]{\tan\tfrac{1}{2}\,\vartheta} \\ m &= [0.06247]\,\operatorname{cosec}\,\vartheta' \end{aligned}\right\} \qquad (7)$$

Secondly, when $\alpha^3 > \frac{\Delta'\,\varphi\,\sqrt{243}}{2}$;

$$\left.\begin{aligned} \sin\,\vartheta &= [6.18617]\,\frac{\Delta'\,\varphi}{\alpha^3} \\ m_1 &= [0.06247]\,\sin\tfrac{1}{3}\,\vartheta \\ m_2 &= [0.06247]\,\sin\,(60^\circ - \tfrac{1}{3}\,\vartheta) \\ m_3 &= [0.06247]\,\sin\,(60^\circ + \tfrac{1}{3}\,\vartheta) \end{aligned}\right\} \qquad (8)$$

Before computing these equations, it is necessary to find the value of α which satisfies the equation,

$$\alpha^3 = \frac{\Delta'\varphi\,\sqrt{243}}{2}$$

which becomes,

$$\alpha = [2.06206]\,\sqrt[3]{\Delta'\,\varphi}$$

when $\Delta\,\varphi$ is expressed in seconds, and α in minutes.

NEW PLANET.

Professor Schumacher has issued the following circular, announcing the discovery of an eleventh asteroid: —

"Letter of Mr. Gasparis to the Editor of the *Astronomische Nachrichten*.

"'*Naples*, 1850, *May* 13.

"'J'ai l'honneur de vous annoncer la découverte d'une nouvelle planète. J'ai fait tous mes efforts pour réaliser dans les cieux une Parthenope à Mr. Herschel, tel étant le nom que ce célèbre astronome anglais avait proposé pour Hygie.

1850.	T. M. à Naples. h. m. s.	Asc. dr. App. ° ′ ″	Décl. App. ° ′ ″
May 11	12 51 53.1	230 21 53.23	—10 35 12.9
[illegible]	11 42 2.5	230 8 28.63	—10 31 58.9

"'On voit que la planète est très près de l'opposition, et par son mouvement montre d'être un astéroïde. Elle est semblable à une étoile de neuvième grandeur.

"'ANNIBAL DE GASPARIS.'

"The date of the second observation is not given, but as the letter was written on the 13th of May, it must have been made on the day between the 11th and the 13th; i. e. on the 12th.

"Mr. Rümker availed himself of a favorable moment on the night of the 27th to 28th of May, to obtain an observation with the ring-micrometer.

	Hamburg M. T.	R.A	Dec.
May 27	11h. 40m. 9s.	226° 40′ 37″.5	—9° 53′ 35″.2.

"At the Observatory here, the planet could not, on account of clouds, be observed in the meridian. Dr. Petersen observed it with the ring-micrometer, and obtained, as the mean of ten good observations, —

	Altona M. T.	α	δ
May 28	11h. 25m. 8s.	226° 28′ 17″.4	—9° 52′ 1″.9

"H. C. SCHUMACHER.

"*Altona*, 1850, *May* 29."

This discovery was previously known in this country through an announcement of the discovery made in the *Tempo di Napoli*. In that journal for May 15, the two observations are given, which Mr. de Gasparis sent to Professor Schumacher, and the following additional one: —

	Naples M. T.	α	δ
May 13	11h. 6m. 35s..6	229° 53′ 41″.2	—10° 28′ 35″.5.

Computers will bear in mind the liability of newspaper paragraphs to typographical errors. G.

FROM LETTERS OF PROFESSOR SCHUMACHER TO THE EDITOR.

Altona, 1850, *May* 30.

Professor Encke brought me yesterday two Berlin observations of the new planet by Galle.

	M. T. Berlin. h. m. s.	α ° ′ ″	δ ° ′ ″	No. Comp.
May 25	11 12 8.0	227 6 42.2	−9 57 16.5	16
" 27	10 20 26.2	226 41 28.0	−9 53 40.4	10

Galle compared with each other three stars which had been observed by Bessel and Lalande.

	α h. m. s.	δ ° ′		
(9)	15 5 58	−9 45.4	$L_1\ B_1 = \ast\, a$	for 1800.0.
(7.8)	15 6 43	45.3	$L_3\ B_1 = \ast\, b$	
(9)	15 5 43	40.3	$L_1\ B_1 = \ast\, c$	

And has thence obtained, from six positions, a mean position for *a* upon which both the observations (May 25, 27) depend.

Parthenope has been observed with our meridian circle (by Sonntag): —

	M. T. Altona. h. m. s.	α ° ′ ″	δ ° ′ ″
May 29	10 36 50	226 16 21.4	−9 50 35.4
" 30	10 32 6	226 4 20.1:	−9 49 9.0

(α not reliable.)

With the ring-micrometer by Dr. Petersen, —

	M. T. Altona. h. m. s.	α ° ′ ″	δ ° ′ ″	No. Comp.
May 28	10 55 15.7	226 16 15.8	−9 50 34.5	9
30	10 25 14.6	226 4 30.2	49 13.6	5
	10 58 19.0	226 4 11.8		2

Petersen's observations on the 30th are to be preferred to the meridian observation on the same day.

Altona, 1850, *May* 31.

The elements of Petersen's comet, which my son has computed, deviate at present about one minute in right ascension (on the parallel), and a few seconds in declination. Götze and Sonntag have used an ephemeris calculated from this orbit, in order to form normal places from the observations we now possess, and thence to deduce new elements. But it is scarcely probable that these will be ready before the closing of the post. It is quite probable that the observations can no longer be represented by a parabola, but the undefined form of the faint nebulosity makes any conclusions from observations as yet quite unsafe, as each different observer will easily observe a different point. It is only very lately that Hind has been able with his great refractor to distinguish a bright point in the nebulosity, which you in America will *a potiori* be able to distinguish and observe with your great refractors; so that we must look to you for the final conclusions concerning the orbit. The nights are at present too light in Pulkowa.

The last observations of the comet with the meridian circle are, —

	Altona M. T. h. m. s.	☄ α ° ′ ″	☄ δ ° ′ ″
May 25	13 59 2	273 1 28.4	+74 16 2.1
26	49 17	271 34 0.3	16 54.9
28	29 1	268 27 30.6	15 40.1
29	13 18 32	266 49 9.0	+74 13 20.0

If the mean time given for these observations and the preceding meridian observations of Parthenope does not come out precisely when you transform the right ascension into mean time, you must not suppose that it is in consequence of any error. Parthenope was, in consequence of an unfavorable atmosphere, and the comet is in itself, too faint to be observed on the threads in an illuminated field. I have, as you recollect, two micrometers in the field of the meridian-circle, with which observations can be made without illuminating, and these were used.

Richard Schumacher's accurately computed ephemeris of Petersen's comet extends only to May 30. But as I do not remember whether I sent you the approximate ephemeris which Sonntag computed to minutes, in order to obtain a general idea of the apparent path, I add the last part of the ephemeris. It is computed for mean Berlin midnight.

1850.	☄ α ° ′	☄ δ ° ′	Log △
June 17.5	232 9	+66 49	9.87934
21.5	226 10	62 45	9.83959
25.5	221 2	57 49	9.79826
29.5	216 11	51 22	9.75696
3.5	213 2	43 20	9.71822
7.5	209 57	33 43	9.68630
11.5	207 20	22 43	9.66616
15.5	205 7	+11 0	9.66174

H. C. SCHUMACHER.

ON THE COLORS OF STARS.

By BENEDICT SESTINI.
PROFESSOR OF NATURAL PHILOSOPHY IN GEORGETOWN COLLEGE, D. C.

In 1845, I published some observations made in Rome on the colored stars, and afterwards, in the year 1847, I published the remaining part of the same observations; and, with the catalogue of stars, a memoir in which I illustrated the hypothesis proposed by Professor Doppler to explain the variation of colors observed in some. Before saying a few words about this hypothesis, it should be remarked that the different states of the atmosphere may be justly reckoned among the causes of the different colors presented by the stars. So that the observations, for instance, made in England will assign different colors to the same stars observed in Italy; not because they have really changed their color, but because the intervening atmosphere is different in different places. In order to discover whether the atmosphere has any influence on the color of the stars, I have repeated in this country many of the observations made in Italy; and, what is still more satisfactory, with the same telescope that I used for many years in Rome, which instrument was the best possessed by the observatory of the Roman College, and so frequently used by my teacher and companion, the late Professor De Vico. The results which I obtained from such comparisons were remarkably uniform; and with a few exceptions much more so than I anticipated. So that, were the state of the air to be ranked amongst the causes of different colors of celestial objects, it seems to me that there is but little difference between this atmosphere and the atmosphere of Italy,—even with regard to transparency. The reason for this conclusion is, that, besides the colored stars, I compared some other observations, always with the same instrument, and always with about the same uniformity of results. Thus, for example, I could see here also one at least of the spots of Venus, which I could only observe with difficulty even in Rome, notwithstanding the practice derived from several thousands of such observations made when Professor De Vico determined the rotation of that planet. The same satisfactory correspondence was found with regard to the observations of some other planets, except those of the ring of Saturn, which, on account of its small inclination, could hardly show any one of the divisions which I had frequently observed in Italy. This uniformity of observations may impart confidence in those on the colored stars, so that certain differences which happened in my observations may deserve at least some attention. I well know that this kind of observations is of such a character as to be subject to illusion. Still, the correspondence found in the greatest number of them, and the change remarked by several observers on double stars, seem to be a sufficient motive not to neglect even this sort of investigations, which I now present as a new specimen.

I said that, save a few exceptions, I found nearly a complete harmony between the observations made at Rome and those repeated here in Georgetown. But this ought to be understood with regard to the single stars, because the double stars were seldom found having the same colors.

(*To be continued.*)

CONTENTS.

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THE

ASTRONOMICAL JOURNAL.

No. 12.

VOL. I. CAMBRIDGE, JULY 17, 1850. NO. 12.

ON THE COLORS OF STARS.

By BENEDICT SESTINI.

PROFESSOR OF NATURAL PHILOSOPHY IN GEORGETOWN COLLEGE, D. C.

(*Continued from page* 88.)

The following table, in which my observations made in both places are compared with the previous ones of Captain Smyth, exhibits specimens of every variety of these changes : —

Name.	C. Smyth's Observations.	Roman Observations.	Georgetown Observations.
Ophiuchi p	s' pale topaz color	s' golden-yellow	s' orange-yellow
	s'' violet	s'' golden-yellow	s'' orange
Herculis ϱ	s' bluish-white	s' yellow	s' white
	s'' pale emerald	s'' deep yellow	s'' white
" B	s' light apple-green	s' golden-yellow	s' yellow
	s'' cherry-red	s'' golden-yellow	s'' yellow
Aquarii ζ	s' very white	s' orange-yellow	s' yellow
	s'' white	s'' light yellow	s'' yellow
Pegasi ε	s' yellow	s' very fine golden-yellow	s' golden-orange
	s'' blue	s'' blue	s'' white
" e	s' pale orange	s' orange	s' golden-orange
	s'' purplish	s'' blue	s'' yellow
Equulei ε	s' white	s' golden-orange	s' yellow
	s'' lilac	s'' blue	s'' blue
Delphini γ	s' yellow	s' orange	s' orange
	s'' light emerald	s'' yellow	s'' yellow
Sagittæ ε	s' pale white	s' yellow	s' yellow
	s'' light blue	s'' bluish-yellow	s'' blue
Cygni β'	s' topaz-yellow	s' golden-orange	s' golden-yellow
	s'' blue	s'' blue	s'' blue
" μ	s' white	s' yellow	s' yellow
	s'' blue	s'' deeper yellow	s'' light yellow
" o'	. . . . .	s' fine yellow	s' golden-yellow
	. . . . .	s'' white	s' blue
Cor. Bor. ζ	s' bluish-white	s' white	s' yellow
	s'' smalt-blue	s'' white	s'' blue
Draconis o	s' orange-yellow	s' fine orange	s' yellow
	s'' lilac	s'' copper tint	s'' light yellow
Cephei β	s' white	s' white	s' white
	s'' blue	s'' white	s'' deep yellow
" δ	s' orange-tint	s' orange	s' bluish yellow
	s'' fine blue	s'' blue	s'' white
Piscium α	s' pale green	s' white	s' white
	s'' blue	s'' white	s'' light yellow
Andromedæ γ	s' orange-color	s' very fine golden-yellow	s' golden-yellow
	s'' emerald-green	s'' white	s'' golden-yellow
Arietis γ	s' bright white	s' white	s' white
	s'' pale gray	s'' white	s'' light yellow
Eridani 32	s' topaz-yellow	s' yellow	s' yellow
	s'' sea-green	s'' white	s'' white
Orionis δ	s' brilliant white	s' light yellow	s' white
	s'' pale violet	s'' brilliant white	s'' white

Besides the alterations observed in double stars, I shall notice only the five out of four hundred stars reviewed that presented a remarkable difference. The following is the list: —

Name.	Roman Observations.	Georgetown Observations.
Sagittar. χ'	deep orange	light yellow
Aquilæ n	deep orange	yellow
Serpent. χ	light yellow	deep orange
Pegasi θ	white	orange
" γ	purplish blue	white

And though I do not maintain that such changes are real, still I prefer to give the original observations, because experience has taught me that nothing is more dangerous than to have the mind preoccupied. For this reason, and in order to be free from every prejudice, I neither recalled the color from former observations, nor looked at the memoir that I wrote in Rome, until the observation of color was finished.

With regard to the hypothesis or explanation of this curious phenomenon, I will here epitomize in a few lines the explanation given in the memoir. The manner in which, according to the hypothesis of Professor DOPPLER, the variation of colors in the stars may be explained, is nothing but a corollary derived from the law with which opticians explain the different colors in the undulatory system. He says, if the variety in the number of undulations produce variety of colors, it is evident that every cause altering that number will be also a cause of a change of color. Now among such causes, there is the motion either of the luminous or of the enlightened body, or of both together. It will be here enough to suppose the motion only on the part of the luminous body: —

P′ P E

And, first, suppose PE to be the distance of a luminous and movable point, P, from the eye, E, of an observer motionless in E. Let t be the time necessary for each undulation to traverse the space PE, and let $t+\theta$ be the time during which the same undulations should run through the space $P'E$. Let n be the number of undulations in a second. It is manifest that if the luminous point is moved from P to P' in T seconds, while the first of the nT undulations performed in the same interval shall strike the observer in E after a time t, the last will reach the same observer after a time $(t+\theta)+T$, and since $(t+\theta)+T-t = T+\theta$; agreeably to this supposition, nT vibrations in the eye, E, during a time $T+\theta$, will correspond to as many undulations performed by the luminous point during a time T. But supposing the luminous point motionless in P, the first as well as the last of nT undulations demands the same interval, t, of time to reach E. Therefore in this case, the nT pulsations will be felt by the eye in the time T. Hence the number of pulsations felt by the retina when the luminous point is motionless is different from that felt by the same retina when that point is in motion, and that difference is given by the ratio $1 : \frac{T}{T+\theta}$. This observation shows well enough what influence the motion of the luminous point may have in affecting variously the retina, and producing different sensations. An analogous alteration should be found in the hypothesis of the motion of the luminous point from P' to P, and supposing every thing else as before, we should obtain the ratio $1 : \frac{T}{T-\theta}$ between the number of pulsations felt by the retina when the point is motionless, and that felt when the point is in motion towards the eye.

Now, making different suppositions with regard to the velocity of the point, we may derive from the preceding ratios the numerical diminution or addition of the pulsations on the retina. It is true, that, without supposing the most rapid motion, any alteration of that number would be hardly perceptible. But such a motion in double stars, in which commonly alteration of color is remarked, seems not improbable. For, according to the law of universal gravitation, velocity depends on the masses and distances. But masses may increase and distances decrease indefinitely, and, of course, no velocity, however great, is improbable in such bodies. Further inquiries in this matter bring to light curious series of phenomena, not very different from some observed in the apparition of new stars, especially in that of Cassiopea, discovered in the year 1572.

PARTHENOPE.

THE Editor has received from Professor SCHUMACHER, who has kindly sent them for the *Astronomical Journal*, under date of June 7, the following observations of the new asteroid.

At Naples: —

1850.	M. T. Naples. h. m. s.	α ° ′ ″	δ ° ′ ″
May 13	12 6 35.6	229 53 41.2	—10 28 35.5
14	10 28 16.8	229 40 36.0	10 25 31.1
15	9 52 50.5	229 26 25.0	10 22 39.1
17	10 59 36.0	228 57 7.0	—10 16 42.0
May 18	11 14 36.2	228 42 41.8	—10 13 52.5
19	10 18 43.3	228 29 20.2	10 11 13.8
20	10 0 37.3	228 15 30.5	—10 8 33.1

At Göttingen, on the meridian by Professor GAUSS: —

	M. T. Göttingen.	α	δ
May 31	10h. 27m. 38s.	225° 52′ 38″.4	—9° 48′ 3″.7

Other observations and elements will be found in the letter of Dr. D'ARREST.

Mr. LUTHER of Berlin has sent the following elements, derived from observations at Naples, May 11, and Berlin, May 25 and June 5: —

Epoch 1850, May 12.0, M. T. Berlin.

M	285° 3′ 25″.47	
π	316 5 9.36	M. Equinox, 1850.0.
☊	125 37 27.61	M. Equinox, 1850.0.
i	4 35 17.51	
φ	5 11 32.06	
μ	930″.96702	
l	0.0904977	
Log. a	0.3873815	
Sid. rev.	1392 days.	

To facilitate the observation of this asteroid in the United States, I have computed the following ephemeris from D'ARREST's elements, and add it, in the hope that it may lead to numerous observations in the United States, where the planet will be observable longer than in Europe. G.

EPHEMERIS OF PARTHENOPE FOR MEAN BERLIN NOON.

1850.	α	δ	Log. $\triangle$	1850.	α	δ	Log. $\triangle$
July 1	222° 55′ 14″.4	—10° 25′ 36″.0	0.204023	Aug. 16	230° 16′ 37″.0	—14° 37′ 58″.7	0.316532
2	56 9.8	29 1.0	0.206412	17	33 56.4	44 44.2	0.318816
3	57 31.0	32 33.7	0.208817	18	230 51 32.2	51 30.7	0.321087
4	222 59 18.1	36 13.9	0.211234	19	231 9 24.2	14 58 18.1	0.323346
5	223 1 30.9	40 1.4	0.213664	20	27 31.8	15 5 6.2	0.325591
6	4 9.2	43 56.3	0.216107	21	231 45 54.6	11 54.8	0.327822
7	7 13.0	47 58.2	0.218571	22	232 4 32.5	18 43.8	0 330040
8	10 42.2	52 7.1	0.221040	23	23 25.7	25 33.2	0.332245
9	14 36.5	10 56 23.0	0.223517	24	232 42 33.6	32 22.7	0.334436
10	18 55.8	11 0 45.5	0.226000	25	233 1 56.1	39 12.3	0.336614
11	23 40.0	5 14.7	0.228491	26	21 33.2	46 1.9	0.338779
12	28 49.1	9 50.3	0.230988	27	233 41 24.8	52 51.2	0.340929
13	34 22.6	14 32.2	0.233490	28	234 1 30.9	15 59 40.3	0.343066
14	40 20.4	19 20.3	0.235996	29	21 51.4	16 6 29.0	0.345189
15	46 42.0	24 14.3	0.238505	30	234 42 26.1	13 17.2	0.347299
16	223 53 27.4	29 14.1	0.241016	31	235 3 14.9	20 4.8	0.349394
17	224 0 36.2	34 19.5	0.243528	Sept. 1	24 17.5	26 51.7	0.351475
18	8 8.2	39 30.4	0.246040	2	235 45 33.8	33 37.6	0 353541
19	16 3.2	44 46.6	0.248552	3	236 7 3 6	40 22.6	0.355594
20	24 20.8	50 8.0	0.251063	4	28 46.9	47 6.5	0.357631
21	30 0.9	11 55 34.3	0.253571	5	236 50 43.6	16 53 49.3	0.359655
22	42 3.0	12 1 5.4	0.256078	6	237 12 53.5	17 0 30.7	0.361663
23	224 51 27.0	6 41.2	0.258581	7	35 16.6	7 10.7	0.363657
24	225 1 12.6	12 21.5	0.251079	8	237 57 42.5	13 49 3	0.365636
25	11 19.5	18 6.1	0.263573	9	238 20 41.1	20 26.3	0.367600
26	21 47.6	23 54.9	0.266062	10	238 43 42.2	27 1.4	0.369549
27	32 36.6	29 47.7	0.268547	11	239 6 55.6	33 34.7	0.371483
28	43 46.1	35 44.4	0.271026	12	30 21.2	40 6.0	0.373402
29	225 55 16.2	41 45.0	0.273500	13	239 53 59.0	46 35.3	0.375306
30	226 7 6.5	47 49.1	0.275969	14	240 17 48.7	53 2.4	0.377195
31	19 16.8	12 53 56.7	0.278431	15	240 41 50.1	17 59 27.0	0.379068
Aug. 1	31 46.9	13 0 7.7	0.280884	16	241 6 3.2	18 5 49.3	0.380926
2	44 36.7	6 21.8	0.283330	17	30 27.8	12 9.0	0.382770
3	226 57 45.9	12 39.0	0.285768	18	241 55 3.8	18 26.0	0.384598
4	227 11 14.3	18 59.1	0.288198	19	242 19 50.9	24 40.3	0.386411
5	25 1.9	25 22.1	0.290618	20	242 44 49.2	30 51.7	0.388209
6	39 8.3	31 47.7	0.293028	21	243 9 58.4	37 0.1	0.389992
7	227 53 33.3	38 15.8	0.295428	22	243 35 18.4	43 5.5	0.391766
8	228 8 16.7	44 46.3	0.297818	23	244 0 49.0	49 7.8	0.393515
9	23 18.3	51 19.0	0.300198	24	26 30.4	18 55 6.8	0.395254
10	38 37.8	13 57 53.8	0.302567	25	244 52 20.2	19 1 2.4	0.396978
11	228 54 15.0	14 4 30.5	0.304924	26	245 18 24.5	6 54.6	0.398687
12	229 10 9.6	11 9.1	0.307270	27	245 44 37.1	12 43.3	0.400382
13	26 21.0	17 49.3	0.309603	28	246 10 56.0	18 28.3	0.402062
14	42 49.4	24 39.1	0.311925	29	246 37 33 0	24 9.6	0.403728
15	229 59 34.8	—14 31 11.3	0.314235	30	247 4 16.1	—19 29 47.2	0.405379

ELEMENTS AND OBSERVATIONS OF THE FIRST COMET OF 1850.

PROFESSOR SCHUMACHER has communicated the following additional information concerning the new comet: —

"ELEMENTS BY D'ARREST.

Mean Equinox, 1850.0. — M. T. Berlin.

T	July 22.06288.
☊	272° 58′ 42″.0
π	92 39 54.5
i	67 52 49.8
Log. q	0.0325246
	Direct.

"From these elements Mr. VOGEL in Berlin has computed an ephemeris for mean Berlin noon, of which the beginning is as follows: —

	α	δ	Log. △
	h. m. s.	° ′	
July 1	14 18 34	+47 50	9.72771
2	14 14 51	45 46	9.71783
3	14 11 17	43 35	9.70830
4	14 7 52	41 20	9.69912
5	14 4 36	38 57	9.69046
6	14 1 28	36 25	9.68242
7	13 58 28	+33 47	9.67516

"According to these elements, the nearest approach of the comet to the earth is, —

	α	δ	Log. △
July 14	13h. 40m. 40s.	+13° 31′	9.64990

The last day for which the ephemeris was computed is,

	α	δ	Log. △
July 23	13h. 22m. 59s.	—12° 0′	9.69203

"Professor SANTINI has sent the following observations made at Padua, by Signor TRATTENORO: —

1850.	M. T. Padua.	☄ α	☄ δ
	h. m. s.	° ′ ″	° ′ ″
May 14	10 26 56.7	285 13 0.0	+73 14 17.7
21	9 52 38.7	278 28 43.8	74 2 11.6
22	9 52 36.4	277 16 35.0	74 6 44.0
27	9 32 48.5	270 17 53.7	74 17 0.6
28	9 21 2.2	268 42 46.0	+74 16 0.1"

Mr. WEYER of Hamburg has sent the Editor the following observations by Mr. RÜMKER: —

	M. T. Hamburg.	☄ α	☄ δ
	h. m. s.	° ′ ″	° ′ ″
May 20	13 7 22.9	279 29 49.1	+73 57 15.9
23	12 19 21.6	275 52 39.3	74 10 36.9
25	11 14 0.7	273 11 14.3	+74 15 35.4

From the observations May 2, Altona and Hamburg, and May 12 and May 20, Hamburg, Mr. WEYER has computed the following elements, for Berlin mean time: —

	I.	Diff.	II.
T	July 21.8951	+1d.1128	July 23.0079
π	272° 57′ 2″.8	+19′ 57″.9	273° 17′ 0″.7
☊	92 38 6.0	+10 2.1	92 48 8.1
i	67 50 42.7	+14 10.6	68 4 53.3
Log. q	0.032208	+0.001036	0.033244
	Motion direct.		Motion direct.

Comparison with the middle observation (C. — O.).

	I.	Diff.	II.
$\varDelta\lambda$	—83″.9	+75″.0	—8″.9
$\varDelta\lambda \cos\beta$	—12.5	+11.2	—1.3
$\varDelta\beta$	— 7.5	+12.1	+4.6

Regard was had to aberration and parallax, by means of earlier orbits. The difference depending on these is inconsiderable. According to the present elements, the distance, at the time of the fundamental observations, was as follows: —

	Log. △
May 2	0.17859
" 12	0.13349
" 20	0.09073

Professor HUBBARD has computed a parabola from the following normals prepared by Professor KEITH of the Washington Observatory: —

Berlin M. T.	α	δ
May 27.03071	270° 52′ 40″.3	+74° 16′ 52″.4
June 3.53144	257 56 27.4	73 37 38.1
11.03219	243 40 25.0	+71 8 19.9

The places here given have been corrected for parallax, and the times for aberration. Professor HUBBARD writes: — "I computed from these places an orbit, and then corrected the M, and repeated the computation. The resulting elements are, —

T	July 23.45523, M. T. Berlin.
n	92° 53′ 43″.8 Mean Equinox, 1850.0.
ω	180 31 9.9
i	68 9 47.1
Log. q	0.0338906

The representation of the middle place is scarcely improved by the correction of the M."

Mr. WALKER has computed the following parabolic elements, founded on the observations made at Altona and Hamburg, May 2, and at Altona, May 15 and 24, — all the small corrections having been taken into account.

T	1850, July 23.01916, M. T. Berlin.	
π	273° 16′ 45″.7	Mean Equinox, 1850.0.
☊	92 50 45.7	
i	68 4 19.6	
Log. q	0.033167	
	Direct.	

The correction of an ephemeris deduced from these elements was, on the 24th June, according to the Washington observations published in this Journal, —

$\cos\delta . \Delta\alpha$	$\Delta\delta$
+6′ 20″	+9′ 5″

As the comet is now conspicuous to the naked eye, the publication of another ephemeris for the month of July will hardly be considered necessary. The length of the period of its appearance, and the accuracy with which the nucleus is at present defined, will afford opportunity for a very accurate determination of its orbit.

G.

FROM A LETTER OF DR. D'ARREST TO THE EDITOR.

Leipsic, Pleissenburg, 1850, *June* 12.

You will doubtless have received from Altona information of the discovery of the newest planet before this reaches you. Through the goodness of Signor Del Re, I am enabled to communicate a series of Neapolitan observations, which are the more valuable, inasmuch as they fill out the interval between the discovery and the commencement of the observations in German Observatories.* . . . . .

Here in Germany, Dr. Galle has been the first to detect the stranger, which was by no means easy, as we had then only the two earliest observations. Soon after, I found it as a star of the 9.10 magnitude, and I now send you all my observations, which ought to be very accurate, as they were made under favorable circumstances and depend on numerous comparisons. I also add some other observations, made at the Berlin and Hamburg Observatories. As the planet is easily visible, in spite of the strong twilight, I hope to be able to observe it for a long time. My observations are still made with the double ring-micrometer of Fraunhofer; but we hope soon to receive a complete filar-micrometer apparatus from Pistor.

Parthenope.

1850.	M. T. Leipsic. h. m. s.	α ° ′ ″	δ ° ′ ″	Comp.
May 29	11 24 28.2	226 16 3.9	—9 50 34.3	12
30	10 56 18.6	226 4 16.7	49 14.9	12
31	10 41 10.4	225 52 35.9	48 4.1	12
June 1	12 2 12.9	225 40 31.7	46 51.4	10
2	11 3 7.4	225 29 44.9	45 59.4	9
5	11 41 38.3	224 57 57.5	44 2.9	9
9	11 16 46.0	224 20 52.7	43 26.3	11
10	11 6 22.6	224 12 37.0	—9 43 43.0	10

Dr. Galle's observations: —

	M. T. Berlin. h. m. s.	α ° ′ ″	δ ° ′ ″
May 25	11 12 8.0	227 6 42.2	—9 57 16.5
27	10 20 26.2	226 41 28.0	—9 53 40.4
28	10 29 27.0	226 28 54.5	—9 52 2.1
29	10 52 2.5	226 16 18.6	50 30.5
30	9 53 19.7	226 4 50.3	49 14.6
31	11 35 35.5	226 52 12.8	—9 47 55.0

Hamburg meridian observations: —

1850.	M. T. Hamburg. h. m. s.	α ° ′ ″	δ ° ′ ″
May 28	10 41 34.4	226 28 30.1	—9 52 4.2
29	10 36 49.6	226 16 15.0	50 30.6
30	10 32 6.1	226 4 18.4	49 15.0
31	10 27 23.1	225 52 32.5	47 59.0
June 1	10 22 41.6	225 41 6.5	46 52.8
2	10 18 0.1	225 29 55.8	45 58.2
3	10 13 22.2	225 19 7.9	—9 45 12.0

I have delayed the determination of the orbit longer than usual this time; but am now able to give the Parthenope-Elements which I have computed from the observations May 11, May 25, and June 5. This orbit can make some claim to precision, being deduced from an interval of twenty-five days. It is as follows: —

Epoch 1850, May 11, 12h., M. T. Berlin.

Mean Anomaly,	289° 43′ 26″.81	
Longitude of Perihelion,	312 25 50.77	M. Equinox, 1850.0.
" " Node,	125 39 21.17	
Inclination,	4 33 36.51	
Angle of Eccentricity,	5 50 47.61	
Log. Semiaxis Major,	0.3880424	
Mean Daily Motion,	928″.8445	
Eccentricity,	0.1018647	

As you will observe, this asteroid occupies no extreme place in any one of its elements; the mean motion is between that of Astræa and that of Hebe.

These data will probably be sufficient to insure its detection at an early date in your American Observatories. . . . . .

* This series of observations is that on p. 90, which had been already received through Professor Schumacher's kindness. G.

The very defective construction of my Observatory will not allow me to institute any observations of Dr. Petersen's comet before the end of June. I can therefore only send you my last elements, which depend upon some observations in Altona, Berlin, and Hamburg, and show a good agreement with the positions as yet obtained. . . . . .

[These elements have been already printed on page 92.]

Taking into account all the small corrections, but omitting parallax, — inasmuch as the comet is as yet farther than the sun from the earth, and its zenith distance is also small, — I obtain the following agreement with the positions as yet communicated to me.

		$\Delta\alpha \cdot \cos\delta$	$\Delta\delta$
May 2	Hamburg,	+3.″7	+15.″9
2	Altona,	+ 1.4	— 6.1
3	Altona,	. . . .	+ 8.5
3	Altona,	+ 7.2	. . . .
3	Hamburg,	—15.5	+ 4.0
4	Hamburg,	—12.5	—15.1
5	Berlin,	— 7.3	0.0
7	Berlin,	+ 4.5	— 5.5
7	Hamburg,	+33.5	— 5.2
8	Hamburg,	+10.9	—10.6
8	Liverpool,	+ 3.2	—15.7
8	Liverpool,	+ 4.9	—17.5
9	Liverpool,	+ 7.6	— 7.4
9	Liverpool,	+10.8	— 8.9
10	Hamburg,	—14.6	—39.0
11	Berlin,	+ 3.6	+ 0.2
12	Hamburg,	+10.0	—11.1
May 12	London,	+ 2.″8	— 8.″3
13	Hamburg,	+16.8	+ 5.8
20	Berlin,	+ 0.9	0.0

Since this comet will remain visible for several weeks, I transmit also part of a calculation of its apparent path, which a young friend of mine has made from the foregoing system of elements.*

Ephemeris for Mean Berlin Noon.

	α	δ	Log. Δ
	h. m. s.	° ′	
July 8	13 55 35	+31 3	9.6689
9	52 49	28 15	9.6636
10	50 11	25 23	9.6592
11	47 39	22 28	9.6556
12	45 14	19 30	9.6527
13	42 55	16 31	9.6508
14	40 40	13 31	9.6499
15	38 29	10 31	9.6502
16	36 22	7 31	9.6519
17	34 19	4 33	9.6549
18	32 19	+ 1 37	9.6589
19	30 22	— 1 17	9.6638
20	28 28	4 6	9.6695
21	26 36	6 51	9.6761
22	24 47	9 29	9.6836
23	22 59	15 5	9.6902
Aug. 4.5	13 6 30	—36 34	9.8226

H. D'ARREST.

* I copy the part not given on p. 92. G.

OBSERVATIONS OF PETERSEN'S COMET OF 1850.*

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant Maury, Director of the Observatory.

[Corrected for refraction.]

Date.	M T. Washington.	No. of Obs.	Star of Comparison.	☄ — * $\Delta\alpha$	☄ — * $\Delta\delta$	☄'s apparent α	☄'s apparent δ
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
June 2	10 6 41.40	10	a	+0 24.16	+11 1.07	17 18 11.10	+73 46 58.65
	11 46 25.78	4	"	—0 7.06	+10 15.42	17 17 39.87	73 46 12.99
3	10 15 58.70	5	2418, Groomb.	+7 0.96	+11 46.11	17 10 39.71	73 36 3.10
	~	5	2420, "	+6 5.61	+ 4 47.43	17 10 39.40	73 35 57.25
([1])		5	*f*	+0 17.19	+ 0 43.87	17 10 40.50	+73 35 58.33

* The observations of June 2, 3, 4, and 5, heretofore sent, are repeated, the stars of comparison having been better determined, and the correction for refraction applied.

([1]) Right-ascension of star of comparison doubtful.

Date.	M. T. Washington.	No. of Obs.	Star of Comparison.	☄ — * $\Delta\alpha$	☄ — * $\Delta\delta$	☄'s apparent α	☄'s apparent δ
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
June 4	9 59 45.38	10	2411, Groomb.	+3 52.83	+ 2 12.07	17 3 13.48	+73 23 28.26
		10	2418, "	—0 23.68	— 0 49.50	17 3 14.47	73 23 28.11
5	10 16 45.11	10	2411, "	—3 49.35	—12 51.92	16 55 31.29	73 8 24.68
		10	*g*	—1 10.83	— 0 45.11	16 55 30.30	73 8 26 01
9	9 19 42.72	5	2356, Groomb.	—1 49.59	+ 3 16.79	16 25 13.15	71 46 30.58
10	10 18 45.74	8	*h*	+1 32.51	+ 6 16.59	16 17 21.74	71 18 44.03
		8	*i*	+1 22.61	— 0 0.12	16 17 21.25	71 18 46.52
	11 4 0.50	4	*h*	+1 16.91	+ 5 20.35	16 17 6.13	71 17 47.79
		4	*i*	+1 7.38	— 1 0.24	16 17 6.02	71 17 46.18
11	9 37 19.16	6	2319, Groomb.	+4 41.79	+ 9 50.99	16 10 7.89	70 49 45.00
		6	*k*	+1 44.20	+ 6 12.37	16 10 7.94	70 49 47.47
12	10 2 11.06	4	*l*	+3 56.64	+ 7 54.83	16 2 40.14	70 15 31.83
		4	*m*	+2 54.48	+ 6 47.59	16 2 40.06	70 15 30.83
	10 12 21.50	5	*n*	—0 34.30	— 2 38.92		
13	9 29 10.00	3	*o*	—3 54.70	+ 3 44.40	15 55 40.17	69 41 34.68
		3	*p*	—4 16.20	+ 2 56.57	15 55 40.04	69 41 31.77
	10 30 42.62	5	*o*	—4 13.06	+ 2 15.60	15 55 21.82	69 40 5.87
		5	*p*	—4 34.33	+ 1 26.15	15 55 21.92	69 40 1.36
13	9 29 10.00	3	*q*	+0 21.11	+ 0 46.67		
	10 30 42.62	5	*q*	+0 2.62	— 0 56.01		
(1) 19	9 5 56.25	8	*r*	—1 43.42	+ 3 42.59	15 16 33.04	64 58 14.49
24	8 53 59.67	2	*s*	—3 53.91	+ 5 21.88	14 49 37.08	59 12 42.34
		2	*t*	—4 7.01	+ 4 45.15	14 49 37.32	59 12 38.75
	9 21 32.90	2	*s*	—3 59.65	+ 3 46.41	14 49 31.34	59 11 6.87
		2	*t*	—4 13.25	+ 3 18.91	14 49 31.08	+59 11 12.52

(1) The declination of the star of comparison doubtful.

Adopted Mean Places for 1850.0 *of Comparison-Stars.*

*	Mag.	α	No. of Obs. and Authority.	δ	No. Obs. and Authority.
		h. m. s.		° ′ ″	
a	9.10	17 17 42.89	1, W. Transit.	+73 35 53.72	2, Mural.
2118, Groomb.	8	17 3 34.06	1, W. Transit.	73 24 11.88	2, Mural.
2420, "	8	17 4 29.67	1, W. Transit.	73 31 4.77	2, Mural.
f	9.10	(1)17 10 19.14	1, W. Transit.	73 35 7.63	1, Mural.
2411, Groomb.	7	16 59 16.59	1, W. Transit.	73 21 10.60	2, Mural.
g	8.9	16 56 37.14	1, W. Transit.	73 9 5.05	2, Mural.
2356, Groomb.	7	16 26 59.25	1, W. Transit.	71 43 4.72	1, Mural.
i	8.9	16 15 55.59	1, W. Transit.	71 18 36.22	2, Mural.
h	8.9	16 15 45 92	14, Equatorial.	71 12 17.50	2, Mural.
k	9	16 8 20.58	6, Equatorial.	70 43 44.46	1, Mural.
2319, Groomb.	7.8	16 5 22.97	Radcliffe Obs.	70 39 43.24	1, Mural.
l	8.9	15 58 40.68	2, W. Transit.	70 7 20.67	1, Mural.
m	8.9	15 59 42.76	2, W. Transit.	70 8 26.94	4, Equatorial.
n	9.10	16 3 11.60	5, Equatorial.	70 17 54.18	5, Equatorial.
o	8.9	15 59 32.56	1, W. Transit.	69 37 50.28	1, Mural.
p	8.9	15 59 53.92	1, W. Transit.	69 38 35.20	1, Mural.
q	10	15 55 16.75	5, Equatorial.	69 39 41.92	1, Mural.
r	10	15 18 14.46	2, W. Transit.	64 54 17.78	2, Mural.
s	8.9	14 53 29.49	1, W. Transit.	59 7 5.48	1, Mural.
t	8.9	14 53 42.85	1, W. Transit.	+59 7 38.63	4, Equatorial.

(1) Imperfect observation of *a*.

NOTE FROM MR. W. C. BOND TO THE EDITOR.

Cambridge, July 10, 1850.

THE following are our latest observations of the comet: —

1850, Cambridge M. S. T., July 6, $10^{h.}\ 9^{m.}\ 45^{s.}$

☄ follows ∗ *a* of the 8th mag., $0^{m.}\ 36^{s.}.27$ 14 Comp.
south of " " " $5'\ 7''.7$ 3 "

We have also comparisons, the same evening, with two other stars not yet reduced.

July 8, $8^{h.}\ 58^{m.}\ 26^{s.}$

☄'s R.A. $= 13^{h.}\ 58^{m.}\ 19^{s.}.5$ } Mean Equinox,
Dec. $= +31°\ 26'\ 12''$ } 1850.0

by three comparisons with ∗ *b* of the 7th magnitude.

July 8, $12^{h.}\ 35^{m.}\ 10^{s.}$

☄'s R.A. $= 13^{h.}\ 57^{m.}\ 51^{s.}.6$ } Mean Equinox,
Dec. $= +31°\ 2'\ 9''$ } 1850.0

by six comparisons with ∗ *c* of the 9th magnitude.

July 9, $8^{h.}\ 53^{m.}\ 4^{s.}$

☄ precedes ∗ *d* of the 9th mag., $0^{m.}\ 43^{s.}.61$ by 8 comp.
north of " " " $2'\ 0''.2$ 5 "

Places of the Stars of Comparison.

	R.A. 1850.0. h. m. s.	Dec. 1850.0. ° ′ ″	
Star *a*	14 3 20	+36 33	Approximate.
b	13 59 47.31	+31 34 15.9	B. A. C. 4694.
c	13 56 10.83	+31 3 17.6	H. C. 25828.
d	13 56 40	+28 44 30	Approximate.

The reduction of previous observations is delayed until we can obtain the positions of the stars used, with the exception of the two following: —

June 6, $9^{h.}\ 40^{m.}\ 45^{s.}$

☄'s R.A. $= 16^{h.}\ 48^{m.}\ 7^{s.}.3$ } Mean Equinox,
Dec. $= +72°\ 52'\ 5''$ } 1850.0

compared with ∗ *e*, ARGEL. Zone 126, 7th magnitude.

June 21, $9^{h.}\ 13^{m.}\ 12^{s.}$

☄'s R.A. $= 15^{h.}\ 5^{m.}\ 10^{s.}.9$ } Mean Equinox,
Dec. $= 62°\ 53'\ 46''$ } 1850.0

compared with ∗ *f*, of the 7th magnitude.

	R.A. 1850.0. h. m. s.	Dec. 1850.0. ° ′ ″	
Star *e*	16 43 12.61	+72 57 6.1	ARGEL. Zone 126.
f	15 17 9.52	+63 0 48.3	Groomb. 2224.

The place of ∗ *f* was taken from the Radcliffe Observations, Vols. IV., V., and VI.

The comet from its first appearance has presented a bright stellar point in its center, as seen through the great refractor. This has enabled us to determine its position relatively to the stars of comparison with probably less error than that to which the tabular places of the comparison-stars are subject.

This central point for a few nights past has not looked so solid and star-like as previously. It seems now in process of expansion into a disc of measurable diameter. A tail of 4° or 5° is visible in the comet-seeker, with an evident curvature, the convexity presented to the zenith.

WILLIAM C. BOND.

CORRIGENDA.

Page 80, col. 2, line 2, after "Observations," insert a semicolon.

Page 86, col. 2, in the second observation of Parthenope, the date of the first, May 11, was repeated. The context would suffice to show the error, but the date was nevertheless obliterated by hand, in all the copies distributed. It will be also observed, that the caution of the Editor regarding too implicit reliance upon the newspaper report of the third Naples observation was not amiss. The time of observation was May 13 $12^{h.}\ 6^{m.}\ 35^{s.}.6$; not $11^{h.}$ as printed. G.

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THE

ASTRONOMICAL JOURNAL.

No. 13.

VOL. I. · CAMBRIDGE, JULY 26, 1850. NO. 13.

ON THE GREAT COMET OF 1844-45.

By G. P. BOND,

ASSISTANT AT THE CAMBRIDGE OBSERVATORY.

THIS comet was first seen at the Cape of Good Hope, on the 18th of December, 1844. On the day following, it was seen by Captain WILMOT, R. A., and by Mr. MACLEAR of the Cape Observatory. In the Monthly Notices of the Astronomical Society, it is usually designated as "WILMOT's" comet. It continued to be visible to the naked eye from the date of its discovery until the end of January, and was followed with the telescope up to the 12th of March.

During the latter part of December and the first week in January, it was a brilliant object in the southern hemisphere, equaling, it is said, in brightness the celebrated comet of HALLEY at its last appearance. After it had ceased to be visible to the naked eye, it approached sufficiently near to the equator to become visible as a telescopic comet in northern latitudes; it was then detected almost simultaneously by Professor COLLA, on the 5th of February, Dr. PETERS, and Mr. COOPER at Naples, on the 7th. To this rediscovery we owe several valuable European observations during the latter part of its course.

A rude resemblance of its elements to those of the comet of 1556 induced me to test the possibility of their being the same, by ascertaining whether the fine series of observations made at the Cape of Good Hope, which include an angle of sixty degrees of heliocentric motion, would be best represented by an elliptical orbit. The elements of the two present great discrepancies, no doubt; but, taking into account the uncertainty of the observed places in 1556, and the fact that, in the month of March of that year, the comet, remaining quite near the earth for nearly three weeks, must have experienced very considerable perturbations, — to which is to be added the effect of other disturbing influences during its revolution of nearly three centuries,—large differences in the elements at the two epochs were to be anticipated. The orbits of each, as given by Mr. J. R. HIND, the first in a pamphlet on the comet of 1556, and the second in No. 510 of the *Astronomische Nachrichten*, are: —

	Comet of 1556.	Comet of 1844-45.
Long. of Perihelion,	274°	296
" of Asc. Node,	175	118
Inclination,	30	46
Perihelion Distance,	0.50	0.25
Period,	292 years.	289 years *if identical.*
Motion Direct.		Motion Direct.

On the whole, the difference of the elements is too large for a probable identity. Their distant resemblance, such as it is, was sufficient to attract attention, however, and was in fact, at the time, brought forward as an argument for careful observations on the latter. It was with a view to decide this question that the following investigation was undertaken.

A review of the observations contained in the numbers of the *Astronomische Nachrichten*, and in the Monthly Notices of the Royal Astronomical Society, induced me to adopt those made at the Cape of Good Hope for the basis of the new orbit.

These included an arc of heliocentric motion greater by fifty degrees than the European; they were very numerous, and having been derived from micrometric measures with small stars, whose places were afterwards accurately determined by the transit and mural circle, it was thought probable that they would be superior in accuracy to any others which we possess. The result has fully justified this course. Indeed, without this valuable series, the question of an eccentricity could scarcely have been settled at all.

The observations included in this discussion were in all one hundred and thirty-eight; viz. eighty-five at the Cape of Good Hope, twenty-five at Trevandrum, thirteen at Naples, and fifteen at Greenwich, Cambridge, Regent's Park, Berlin, and Altona.

The date of each has been reduced to decimals of a day for the meridian of Greenwich. Corrections have been applied in all cases for parallax, and the whole referred to the mean equinox of January 1, 1845.

OBSERVATIONS ON THE GREAT COMET OF 1844-45,

Reduced to the Mean Equinox of 1845, January 1.

Gr. M. S. T.	1844. d.	R. A. ° ′ ″	N. P. D. ° ′ ″
Cape of Good Hope, Dec.	21.29114	295 48 11.1	128 12 23.1
	27.29199	304 12 34.4	131 3 45.5
	27.30810	304 15 21.9	131 4 32.7
	28.28811	307 7 48.0	131 50 52.6
	28.32891	307 14 57.0	131 52 41.5
	30.30879		133 10 17.1
	30.30905	313 13 58.4	
	30.32786	313 17 26.2	
	30.32818		133 11 4.5
	30.34577	313 20 47.4	133 11 29.0
	31.30381	316 18 49.1	133 41 13.2
	31.32961	316 23 35.2	133 41 57.2
1845, Jan.	1.31183	319 28 17.7	134 6 44.9
	3.33788	325 53 21.7	134 40 30.6
	5.36447	332 18 40.1	134 50 48.7
	6.29183	335 13 16.5	134 47 43.4
	6.32999	335 20 18.4	134 47 36.6
Trevandrum,	8.08261	340 44 24.9	134 29 31.1
	9.08103	343 44 11.3	134 11 17.6
Cape of Good Hope,	9.32505	344 26 45.4	134 7 0.4
	9.34127	344 29 29.3	
	9.35159		134 6 26.9
	9.36418	344 33 39.4	
Trevandrum,	10.08392	346 39 11.6	133 50 49.4
	11.07333	349 28 7.6	133 24 54.5
Cape of Good Hope,	11.34047	350 13 14.7	133 16 41.2
Trevandrum,	12.07341	352 14 26.4	132 55 1.1
Cape of Good Hope,	12.33392	352 56 44.7	132 45 59.0
	12.36136	353 1 0.9	132 45 14.2
Trevandrum,	14.07507	357 29 27.0	121 45 15.6
	15.08157	359 59 29.2	131 5 58.5
Cape of Good Hope,	15.34222	0 37 21.9	130 54 31.0
	15.36399	0 40 15.7	130 53 45.6
Trevandrum,	16.08996	2 22 15.6	130 24 10.6
Cape of Good Hope,	16.38899	3 5 12.7	130 10 28.9
Trevandrum,	17.08336	4 40 8.0	129 40 52.2
Cape of Good Hope,	17.37464	5 18 50.9	129 27 4.5
Trevandrum,	18.07919	6 51 32.4	128 56 0.1
Cape of Good Hope,	18.35224	7 25 57.0	128 42 31.6
Trevandrum,	19.08197	8 57 37.1	128 9 2.9
Cape of Good Hope,	19.35783	9 31 8.1	127 55 20.3
	19.37901	9 33 54.7	127 54 21.2
Trevandrum,	20.07789	10 57 42.1	127 21 19.9
	21.10438	12 56 3.1	126 31 33.4
	22.08321	14 44 10.9	125 43 57.0
Cape of Good Hope,	22.32673	15 9 53.2	125 31 27.6
	22.36218	15 13 42.8	125 29 45.4
Trevandrum,	23.07956	16 29 12.7	124 55 3.9
Cape of Good Hope,	24.32591	18 31 21.7	
	24.33855		123 52 3.6
	24.37429	18 39 6.0	
Trevandrum,	25.08702	19 47 56.7	123 15 47.0
Cape of Good Hope,	25.31993	29 9 31.3	123 3 32.2
	25.34476	20 11 50.9	123 2 17.3
Trevandrum,	26.08359	21 19 58.9	122 26 23.0
	27.09250	22 50 22.7	121 36 53.2
Cape of Good Hope,	27.35771	23 12 17.5	121 23 31.4

1845. Gr. M. S. T.	d	R.A. ° ′ ″	N. P. D. ° ′ ″
Trevandrum, Jan.	28.09151	21 15 10.1	120 48 40.2
Cape of Good Hope,	28.35224	24 36 2.1	120 35 24.9
Treyandrum,	29.09796	25 36 51.8	120 0 10.4
Cape of Good Hope,	29.35230	25 56 42.6	119 47 13.7
Trevandrum,	30.08141	26 53 56.6	119 12 52.3
Cape of Good Hope,	30.35946	27 14 50.1	
	31.35006	28 28 47.7	
	31.36613		118 12 33.2
	31.38296	28 31 16.0	
Trevandrum, Feb.	1.14942	29 27 15.5	117 36 38.0
Cape of Good Hope,	1.35082	29 40 33.4	
	1.36595		117 26 29.3
	1.38137	29 42 47.6	
Trevandrum,	3.12173	31 38 56.6	116 8 32.6
Cape of Good Hope,	3.34330	31 55 37.3	
	3.35833		115 57 4.4
	3.37396	31 57 40.5	
Trevandrum,	4.10900	32 45 47.3	115 24 45.3
Cape of Good Hope,	4.33072	32 59 13.4	
	4.34592		115 13 52.0
	4.36075	33 1 13.1	
Trevandrum,	5.10632	33 48 7.2	114 41 18.3
Naples,	7.28623	35 57 5.7	113 10 10.7
	8.25529	36 51 40.8	112 30 5.3
Cape of Good Hope,	8.32929		112 28 8.0
	8.34766	36 56 17.5	
	8.36412		112 26 40.8
Naples,	9.31045	37 49 50.9?	111 49 23.4?
Cape of Good Hope,	9.33233	37 49 55.8	
	9.34472		111 48 0.4
	9.35960	37 51 25.7	
	10.34166	38 43 1.3	
	10.35152		111 9 0.4
	10.36983	38 44 29.9	
	16.32155	43 28 47.6	
	16.33131		107 35 32.6
	16.34061	43 29 45.7	
Naples,	17.25800	44 9 7.7	107 4 54.5
	18.27182	44 53 44.5	106 32 12.7
Cape of Good Hope,	18.31963	44 55 2.0	
	18.33562		106 30 18.7
	18.34975	44 56 17.1	
Naples,	19.27726	45 34 30.0	106 1 11.0
	20.27214	46 15 30.8	105 30 49.4
	20.27753	46 14 1.7	105 30 32.0
	20.28177	46 16 17.8	105 29 40.4
Altona,	24.30407	48 50 45.3	
	24.30939		103 33 0.2
Naples,	25.29440	49 25 36.3	103 5 59.6
Berlin,	25.30073	49 27 19.4	103 5 57.5
Naples,	26.27670	50 2 43.3	102 39 12.0
Cape of Good Hope,	27.29538	50 37 52.6	
	27.31043		102 12 45.2
	27.32571	50 39 3.0	
	28.30292	51 12 53.3	
	28.31420		101 47 8.3
	28.32515	51 13 33.4	

1845. Gr. M. S. T.		R.A.	N. P. D.
	d.	° ′ ″	° ′ ″
Regent's Park, March	3.30594	52 55 56.6	
	3.30721		100 34 12.8
Greenwich,	3.32986	52 51 45.0	100 33 36.7
Cape of Good Hope,	4.32424		100 10 23.5
	4.33814	53 26 36 7	
Greenwich,	4.30488	53 25 29.5	100 10 53.2
Berlin,	5.29297	53 56 54.5	99 48 24.6
Cape of Good Hope,	5.31535	53 57 58.7	
	5 32973		99 47 33.4
Cambridge,	5.32840	53 59 11.1	99 47 32.4
Greenwich,	5.32074	53 58 14.4	99 47 45.1
Cape of Good Hope,	6.32180	54 29 40.0	
Cape of Good Hope, March	6.33284		99 25 10.9
Naples,	7.27045	54 58 10.0	99 4 29.8
Cambridge,	7.31865	55 0 20.5	99 3 49.1
Greenwich,	7.32217	55 0 15.1	99 3 32.1
Berlin,	8.27575	55 29 35.3	98 43 34.0
	9.29090	56 0 24.8	98 21 59.7
Cape of Good Hope,	9.29618	56 0 22.1	
	9.31653		98 21 45.1
Naples,	11.28000	56 58 4.7	97 42 11.5
Cambridge,	11.31622	57 0 51.4	97 41 12.3
Cape of Good Hope,	12.29993	57 28 45.3	
	12.31401		97 22 10.7

In computing the parallax, the ephemeris published by Mr. HIND in the *Astronomische Nachrichten*, No. 540, was used; the corrections for aberration, precession, and nutation were computed for every tenth day, and applied, in the same manner as for a star, to the apparent places of the comet.

Approximate parabolic values were then assumed for the heliocentric coördinates x, y, and z, of the comet, on the 1st of January, referred to the equator, and to the mean equinox, and for its diurnal velocity in the direction of x, y, and z. With these the heliocentric coördinates were computed by the method of quadratures, for each Greenwich mean noon from the 24th of December to the 12th of March. The part of aberration depending on the comet's motion was taken account of by diminishing each coördinate by the amount of its change during the interval required by light to pass from it to the earth.

The sun's radius-vector and apparent longitude were taken from the Nautical Almanac, and the latter reduced to the mean equinox. With the mean obliquity of the ecliptic, corrected so as to include the effect of the sun's latitude, the earth's coördinates were found. The following ephemeris was then constructed, depending on the assumed values for January 1: —

$x = +0.3328687$ Velocity in the direction of $x = +0.0019253.60$
$y = +0.4246110$ " " " " $y = +0.0309202.10$
$z = -0.2874597$ " " " " $z = -0.0028786.70.$

EPHEMERIS OF THE GREAT COMET OF 1844-45.

1844-45.	R.A. 1845.0.	p	q	s	N. P. D. 1845.0.	p'	q'	s'
Dec. 24	295° 1′ 34.″4	+9671.″4	+109.″2	+2.″5	127° 51′ 12.″9	+3932.″7	−135.″4	−1.″6
25	297 44 37.5	9897.0	115.3	1.4	128 57 28.6	3657.2	140.2	1.6
26	300 31 31.2	10131.0	117.7	+0.3	129 56 4.0	3371.9	145.0	1.6
27	303 22 20.2	10366.9	116.8	−1.0	130 49 49.3	3077.2	149.9	1.7
28	306 17 2.9	10596.8	111.8	2.3	131 38 34.9	2772.0	155.3	1.7
29	309 15 29.2	10812.8	103.0	3.6	132 22 9.9	2456.3	160.3	1.6
30	312 17 21.5	11007.3	90.1	4.8	133 0 24.3	2130.9	165.0	1.4
31	315 22 14.1	11172.7	71.2	5.9	133 33 8.8	1797.0	168.7	1.2
Jan. 1	318 29 35.1	11302.8	54.9	6.9	134 0 15.9	1456.1	171.6	0.7
2	321 38 45.9	11391.6	32.2	7.6	134 21 39.7	1111.2	172.9	−0.2
3	324 49 3.1	11434.6	+ 9.4	8.0	134 37 17.8	765.0	172.8	+0.3
4	327 59 39.0	11428.8	− 15.3	8.1	134 47 10.3	420.8	170.8	0.9
5	331 9 44.4	11373.9	39.6	8.0	134 51 21.2	+ 82.0	167.4	1.5
6	334 18 30.6	11269.4	64.3	7.6	134 49 57.3	− 248.0	162.0	2.0
7	337 25 8.2	11118.8	86.8	7.2	134 43 9.3	565.8	155.4	2.5
8	340 28 52.2	10922.8	107.7	6.5	134 31 10.6	868.7	147.0	2.9
9	343 29 0.8	10688.4	125.7	5.5	134 14 17.8	1153.8	137.6	3.3
10	346 24 58.0	10420 8	141.0	4.6	133 52 49.7	1419.1	127.4	3.5
11	349 16 13.2	10125.6	153.3	3.6	133 27 6.7	1663.1	116.4	3.7
12	352 2 21.9	9808 5	162.7	2.6	132 57 30.9	1884.7	105.2	3.8
13	354 43 5.1	9475.0	168.9	1.7	132 24 24.8	2083.4	93.6	3.7
14	357 18 10.5	9133.6	172.7	0.9	131 48 11.5	2259.5	82.4	3.7
15	359 47 30.5	8786.0	174.1	−0 1	131 9 13.3	2413.0	71.3	3.6
16	2 11 2.3	+8437.9	−173.4	+0.5	130 27 52.6	−2544 9	−60.8	+3.4

1845.	R.A. 1845.0.	p	q	s	N. P. D. 1845.0.	p'	q'	s'
	° ′ ″	″	″	″	° ′ ″	″	″	″
Jan. 17	4 28 47.3	+8093.0	−171.0	+1.0	129 44 30.3	−2656.2	−50.6	+3.2
18	6 40 50.3	7751.4	167.2	1.4	128 59 26.7	2747.9	41.3	3.0
19	8 47 18.9	7424.1	162.5	1.7	128 13 0.5	2821.7	32.6	2.8
20	10 48 22.5	7104.9	156.7	2.0	127 25 29.0	2878.8	24.8	2.5
21	12 44 12.7	6797.6	150.6	2.1	126 37 7.7	2920.9	17.5	2.3
22	14 35 1.8	6502.8	144.0	2.2	125 48 11.8	2949.3	11.0	2.1
23	16 21 2.8	6221.6	137.0	2.3	124 58 53.6	2965.5	5.3	2.0
24	18 2 29.7	5954.3	130.4	2.2	124 9 24.8	2970.6	− 0.1	1.7
25	19 39 35.8	5700.5	123.4	2.3	123 19 55.8	2966.1	+ 4.2	1.4
26	21 12 35.2	5460.4	116.8	2.2	122 30 35.3	2953.5	8.1	1.2
27	22 41 41.0	5233.3	110.4	2.2	121 41 31.1	2933.6	11.6	1.0
28	24 7 6.1	5019.0	103.9	2.1	120 52 50.1	2907.4	14.6	0.9
29	25 29 3.3	4817.3	97.9	1.9	120 4 38.2	2875.8	16.7	0.7
30	26 47 44.6	4627.2	92.2	1.9	119 16 59.8	2840.1	19.0	0.7
31	28 3 21.5	4448.2	86.9	1.8	118 29 59.4	2800.2	20.7	0.5
Feb. 1	29 16 4.6	4279.9	81.5	1.7	117 43 40.4	2757.4	22.0	0.4
2	30 26 4.7	4121.8	76.9	1.5	116 58 5.4	2712.1	23.2	0.3
3	31 33 31.1	3972.7	72.3	1.5	116 13 16.8	2664.9	24.0	0.3
4	32 38 33.0	3832.7	67.8	1.4	115 29 16.2	2616.1	24.7	0.2
5	33 41 19.3	3701.0	63.9	1.3	114 46 5.0	2566.2	25.2	0.2
6	34 41 57.8	3577.1	60.2	1.2	114 3 44.2	2515.4	25.4	+0.1
7	35 40 35.9	3460.4	56.6	1.0	113 22 14.3	2464.2	25.6	0.0
8	36 37 20.8	3350.6	53.2	1.0	112 41 35.7	2413.0	25.7	0.0
9	37 32 19.2	3247.1	50.4	1.0	112 1 48.4	2361.7	25.6	0.0
10	38 25 36.9	3149.5	47.3	0.9	111 22 52.3	2310.0	25.5	0.0
11	39 17 20.0	3057.4	44.9	0.9	110 44 47.3	2259.7	25.3	−0.1
12	40 7 33.4	2970.5	42.2	0.8	110 7 32.8	2209.5	25.0	0.1
13	40 56 22.5	2888.6	39.8	0.7	109 31 8.2	2159.8	24.6	0.1
14	41 43 52.0	2810.9	37.8	0.7	108 55 32.9	2111.0	24.3	0.1
15	42 30 5.8	2737.5	35.5	0.7	108 20 46.1	2062.9	23.9	0.1
16	43 15 8.5	2668.3	33.7	0.6	107 46 47.0	2015.4	23.4	0.2
17	43 59 3.7	2602.7	32.0	0.6	107 13 31.8	1969.3	22.9	0.1
18	44 41 55.0	2540.5	30.2	0.5	106 41 8.3	1923.8	22.4	0.2
19	45 23 45.8	2481.5	28.7	0.5	106 9 26.7	1879.5	22.0	0.1
20	46 4 39.1	2425.6	27.1	0.5	105 38 29.1	1835.9	21.4	0.2
21	46 44 38.1	2372.7	25.7	0.5	105 8 14.4	1793.8	20.9	0.1
22	47 23 45.6	2322.5	24.5	0.4	104 38 41.4	1752.3	20.3	0.2
23	48 2 4.0	2274.7	23.2	0.4	104 9 49.0	1712.2	20.0	0.1
24	48 39 35.9	2229.4	22.0	0.4	103 41 36.7	1672.6	19.4	0.2
25	49 16 23.7	2186.4	21.0	0.4	103 14 3.3	1634.4	18.8	0.1
26	49 52 29.5	2145.6	19.9	0.3	102 47 7.6	1597.1	18.4	0.1
27	50 27 55.5	2106.6	19.0	0.3	102 20 48.8	1560.8	18.0	0.1
28	51 2 43.4	2069.6	18.0	0.3	101 55 5.9	1525.2	17.5	0.1
March 1	51 36 55.3	2034.3	17.2	0.3	101 29 58.1	1490.6	17.1	0.1
2	52 10 32.7	2000.6	16.4	0.3	101 5 24.5	1456.9	16.6	0.1
3	52 43 37.2	1968.6	15.6	0.3	100 41 24.1	1424.1	16.2	0.1
4	53 16 10.5	1938.2	14.9	0.2	100 17 56.1	1392.1	15.8	0.1
5	53 48 14.0	1909.0	14.3	0.2	99 54 59.7	1360.9	15.4	0.1
6	54 19 48.9	1881.0	13.6	0.2	99 32 34.1	1330.5	15.0	0.1
7	54 50 56.5	1854.5	13.0	0.2	99 10 38.5	1300.8	14.6	0.1
8	55 21 38.2	1829.0	12.6	0.2	98 49 12.2	1272.0	14.3	0.1
9	55 51 54.8	1804.5	12.0	0.2	98 28 14.4	1243.8	13.9	0.1
10	56 21 47.5	1781.0	11.6	0.2	98 7 44.4	1216.4	13.6	0.1
11	56 51 17.1	1758.5	11.0	0.2	97 47 41.5	1189.6	13.2	0.1
12	57 20 24.8	+1737.1	−10.5	+0.1	97 28 5.0	−1163.6	+12.9	−0.1

The columns p, q, s, p', q', and s', facilitate the process of interpolation. For any small interval t, the

Change of R.A. $= pt + qt^2 + st^3$ Change of N. P. D. $= p't + q't^2 + s't^3$.

The neglected terms will be less than one tenth of a second of arc, if t is reckoned from the nearest date of the ephemeris.

The R.A. and N.P.D. were then interpolated for the date of each observation. This comparison furnished the following

corrections; — the positive sign indicating that the computed R.A. or N.P.D. is smaller than the observed, and the negative sign the contrary.

COMPARISON OF THE EPHEMERIS WITH OBSERVATION.

Date.	Place of Observation.	d R.A.	d N.P.D.	Date.	Place of Observation.	d R.A.	d N.P.D.
1844, Dec. 24	Cape of Good Hope,	— 51.″9	— 55.″2	1845, Jan. 30	Cape of Good Hope,	— 25.″9	
27	“ “	— 24.5	— 49.5	31	“ “	— 20.3	— 23.7
27	“ “	— 23.3	— 50.5	31	“ “	— 16.3	
28	“ “	— 20.5	— 48.9	Feb. 1	Trevandrum,	+ 33.3	— 10.9
28	“ “	— 23.4	— 48.3	1	Cape of Good Hope,	— 22.7	— 24.6
30	“ “	— 13.1	— 49.5	1	“ “	— 17.4	
30	“ “	— 13.7	— 41.4	3	Trevandrum,	—157.0	+ 39.8
30	“ “	— 10.8	— 52.4	3	Cape of Good Hope,	— 29.1	— 20.6
31	“ “	— 6.2	— 46.0	3	“ “	— 26.2	
31	“ “	— 9.5	— 15.5	4	Trevandrum,	+ 17.3	+ 11.4
1845, Jan. 1	“ “	— 7.1	— 48.3	4	Cape of Good Hope,	— 19.8	— 22.2
3	“ “	— 5.7	— 46.0	4	“ “	— 13.8	
5	“ “	— 4.0	— 40.2	5	Trevandrum,	+ 15.1	— 14.2
6	“ “	— 7.0	— 47.7	7	Naples,	+ 3.8	— 26.4
6	“ “	— 3.7	— 41.2	8	“	+ 8.2	— 76.1
8	Trevandrum,	+ 31.1	— 17.6	8	Cape of Good Hope,	— 21.7	— 15.9
9	“	+ 45.2	— 85.8	8	“ “		— 19.7
9	Cape of Good Hope,	+ 3.7	— 47.9	9	Naples,	+ 48.5	— 14.3
9	“ “	— 4.6	— 48.1	9	Cape of Good Hope,	— 16.9	— 16.9
9	“ “	+ 2.8		9	“ “	— 14.7	
10	Trevandrum,	— 19.9	— 0.3	10	“ “	— 26.2	— 16.1
11	“	— 27.3	— 9.4	10	“ “	— 25.3	
11	Cape of Good Hope,	— 4.1	— 39.4	16	“ “	— 35.6	— 9.3
12	Trevandrum,	+ 5.4	— 10.8	16	“ “	— 27.7	
12	Cape of Good Hope,	+ 5.6	— 51.0	17	Naples,	— 65.3	— 13.7
12	“ “	— 4.1	— 42.0	18	“	+ 21.2	— 14.3
14	Trevandrum,	— 8.1	— 5.8	18	Cape of Good Hope,	— 11.9	— 6.4
15	“	+ 13.2	+ 2.5	18	“ “	— 22.8	
15	Cape of Good Hope,	+ 5.0	— 48.2	19	Naples,	— 41.6	+ 23.7
15	“ “	— 9.7	— 40.0	20	“	— 6.4	+ 38.3
16	Trevandrum,	— 84.4	+ 7.4	20	“	—108.5	+ 30.7
16	Cape of Good Hope,	— 5.6	— 45.0	20	“	+ 17.3	— 13.1
17	Trevandrum,	+ 7.3	+ 3.7	24	Altona,	— 6.5	— 0.9
17	Cape of Good Hope,	— 4.4	— 43.8	25	Naples,	— 89.3	+158.6
18	Trevandrum,	+ 29.1	+ 11.3	25	Berlin,	+ 0.1	+ 4.0
18	Cape of Good Hope,	— 4.1	— 42.2	26	Naples,	+ 21.6	— 35.1
19	Trevandrum,	+ 10.7	— 6.1	27	Cape of Good Hope,	— 23.4	— 0.8
19	Cape of Good Hope,	— 6.8	— 46.5	27	“ “	+ 3.4	
19	“ “	+ 5.2	— 45.4	28	“ “	— 15.2	— 0.3
20	Trevandrum,	+ 7.2	— 24.7	28	“ “	— 21.0	
21	“	+ 2.5	— 29.4	March 3	Regent's Park,	+138.6	+ 4.8
22	“	+ 9.0	— 9.4	3	Greenwich,	+ 20.1	+ 0.6
22	Cape of Good Hope,	— 17.8	— 39.5	4	“	— 30.5	0.0
22	“ “	— 15.3	— 36.9	4	Cape of Good Hope,	— 27.5	— 2.8
23	Trevandrum,	— 4.2	+ 6.2	5	Berlin,	— 37.6	+202.3
24	Cape of Good Hope,	— 14.7	— 35.6	5	Cape of Good Hope,	— 15.8	+ 0.7
24	“ “	— 14.1		5	Greenwich,	— 10.3	+ 0.3
25	Trevandrum,	+ 5.7	+ 9.3	5	Cambridge,	+ 31.7	+ 11.4
25	Cape of Good Hope,	— 15.6	— 35.2	6	Cape of Good Hope,	— 12.8	— 2.0
25	“ “	— 15.5	— 36.5	7	Naples,	— 67.0	— 18.0
26	Trevandrum,	— 11.9	— 5.5	7	Cambridge,	— 25.6	+ 3.6
27	“	+ 38.5	— 4.8	7	Greenwich,	— 37.5	— 8.8
27	Cape of Good Hope,	— 21.4	— 31.8	8	Berlin,	— 26.2	+ 11.5
28	Trevandrum,	+ 25.6	+256.1	9	“	— 13.9	— 14.0
28	Cape of Good Hope,	— 19.0	— 22.9	9	Cape of Good Hope,	— 26.2	+ 3.0
29	Trevandrum,	— 2.5	+ 13.7	11	Naples,	— 73.9	+ 2.1
29	Cape of Good Hope,	— 25.7	— 33.5	11	Cambridge,	+ 19.3	— 14.3
30	Trevandrum,	+165.9	— 17.5	12	Cape of Good Hope,	— 19.6	+ 9.8

From the foregoing table we obtain for the normal corrections: —

	In R.A. × sin N.P.D.	In N.P.D.
1845, Jan. 1	— 5.″9	—17.″0
11	1.5	41.5
21	7.5	40.3
31	20 0	26.2
Feb. 10	20.8	16.5
23	13.5	— 3.6
March 8	—18.4	+ 2.9

The perturbations of x, y, and z, produced by the principal planets were next computed for intervals of ten days, as follows, — the units representing the seventh place of decimals: —

1845.	$\frac{d^2\delta x}{dt^2}$	δx	$\frac{d^2\delta y}{dt^2}$	δy	$\frac{d^2\delta z}{dt^2}$	δz
Jan. 1	+1.9	0.0	—1.6	0.0	+1.5	0.0
11	2.5	+ 1.0	2.4	— 0.9	1.4	+ 0.7
21	2.8	4.5	2.5	4.2	1.6	2.8
31	2.5	10.8	3.0	10.0	1.6	6.5
Feb. 10	2.0	19.6	3.0	18.8	1.6	11.8
20	1.5	30.4	3.4	30.6	1.6	18.7
March 2	+1.0	42.7	—4.0	45.8	+1.5	27.2
12		+56.0		—65.0		+37.2

The consequent changes in R.A. and N.P.D., being less than a second of arc, have been neglected.

The assumed constants of the orbit were now successively increased by the quantities: —

Change of $x = +0.001$	Change of velocity in the direction of $x = +0.00001$
" $y = +0.001$	" " " " " $y = +0.00001$
" $z = +0.001$	" " " " " $z = +0.00001$.

And the corresponding variations of the geocentric R.A. and N.P.D. were computed by the method of quadratures, for each constant, at intervals of ten days. In this manner were obtained the coefficients of the unknown quantities in the equations of condition. The first members are the normal corrections of the ephemeris at the dates; the unknown quantities are the corrections to be applied to the assumed constants in order to satisfy the observed places.

Equations of Condition in R.A.

	R.A. sin N.P.D.							
1845, Jan. 1	— 5.″9	=	+141.″4 δx	+160.″9 δy	— 0.″0 δz	+ 0.″0 $\delta\frac{dx}{dt}$	+ 0.″0 $\delta\frac{dy}{dt}$	—0.″0 $\delta\frac{dz}{dt}$
11	— 1.5	=	+ 50.2	+217.8	—10.8	+ 4.2	+21.2	—0.4
21	— 7.5	=	— 9.8	+205.8	—23.4	— 7.0	+38.9	—1.2
31	—20.0	=	— 26.7	+165.0	—27.8	—20.3	+46.4	—1.9
Feb. 10	—20.8	=	— 24.2	+124.5	—26.5	—30.5	+47.4	—2.3
23	—13.5	=	— 13.8	+ 82.8	—21.1	—39.1	+44.2	—2.3
March 8	—18.4	=	— 4.0	+ 49.4	—14.2	—44.9	+39.4	—2.1

Equations of Condition in N.P.D.

Jan. 1	—47.″0	=	+111.″0 δx	—98.″2 δy	+153.″5 δz	+ 0.″0 $\delta\frac{dx}{dt}$	— 0.″0 $\delta\frac{dy}{dt}$	+ 0.″0 $\delta\frac{dz}{dt}$
11	—44.5	=	+135.9	—27.6	+148.1	+14.2	— 2.7	+15.3
21	—40.3	=	+ 98.1	+24.8	+131.3	+21.8	+ 5.1	+29.9
31	—26.2	=	+ 53.0	+30.2	+107.5	+20.2	+11.0	+41.5
Feb. 10	—16.5	=	+ 20.3	+13.3	+ 84.7	+15.1	+11.9	+49.2
23	— 3.6	=	— 5.9	—14.7	+ 61.9	+ 8.7	+ 8.6	+54.8
March 8	+ 2.9	=	— 22.1	—39.5	+ 45.6	+ 3.8	+ 3.8	+57.8

In combining these equations by the method of least squares, I have given to each a weight not strictly proportional to the coefficient of the unknown quantity for which the final equation was desired, but have used numbers easy to multiply and to divide by, there being no difficulty in selecting such as shall nearly represent those required by theory. This saves at least two thirds of the labor of forming the final equations, while the sum of the squares of the errors remains as near a minimum as is practically useful. The following are the final equations formed as stated above: —

Final Equations.

$-164''.5$	$=$	$+685''.3\,\delta x$	$+153''.0\,\delta y$	$+569''.5\,\delta z$	$+74''.5\,\delta\frac{dx}{dt}$	$-14''.9\,\delta\frac{dy}{dt}$	$+67''.8\,\delta\frac{dz}{dt}$
-67.1	$=$	$+129.6$	$+1811.1$	-325.3	-124.3	$+320.0$	$+22.9$
-215.6	$=$	$+571.3$	-308.5	$+895.0$	$+117.4$	-16.9	$+210.8$
$+4.2$	$=$	$+69.5$	-132.2	$+118.6$	$+66.0$	-57.6	$+36.6$
-42.6	$=$	-16.1	$+317.5$	-18.9	-55.8	$+102.9$	$+13.5$
-37.5	$=$	$+66.1$	-4.9	$+199.8$	$+30.5$	$+17.7$	$+108.7$

The solution of these equations gives, —

$$\delta x = +0.11014 \qquad \delta\frac{dx}{dt} = +0.53665$$

$$\delta y = -0.11487 \qquad \delta\frac{dy}{dt} = +0.12452$$

$$\delta z = -0.49455 \qquad \delta\frac{dz}{dt} = +0.32146$$

Without proceeding further, we may at once perceive the character of the new orbit; for the corrections of x, y, and z, &c. have the effect of increasing the sum of their squares, or of increasing the distance of the comet from the sun, at the same time that its velocity is increased. The resulting orbit must therefore be an hyperbola.

The new constants are, —

$$\text{Jan. 1, 1845,}\quad x = +0.3329788 \qquad \frac{dx}{dt} = +0.0019307.26$$

$$y = +0.4245261 \qquad \frac{dy}{dt} = +0.0309214.55$$

$$z = -0.2879542 \qquad \frac{dz}{dt} = -0.0028754.55$$

and are equivalent to the following hyperbolic elements. Elements I. are those of the original parabola by HIND; II., the new hyperbola.

	I.	II.
Perihelion Passage,	Dec. 13.68294, 1844.	Dec. 13.674775
Longitude of Perihelion,	296° 0′ 32″	296° 2′ 17″.77
" Ascending Node,	118 23 24	118 19 21.80 Mean Equinox, 1845.0.
Inclination,	45 36 34	45 38 46.62
Log. of Perihelion Distance,	9.4001230	9.4009126
Motion Direct.		Direct.
		Eccentricity, 1.00035303

Comparison with the Normal Places.

	Correction of the computed R.A. Error × sin N. P. D. Elements I.	Elements II.	Correction of the computed N. P. D. Elements I.	Elements II.
1845, Jan. 1	$-5''.9$	$-3''.0$	$-47''.0$	$+5''.4$
11	-1.5	$+7.9$	-44.5	-1.6
21	-7.5	$+4.9$	-40.3	-5.3
31	-20.0	-6.1	-26.2	-1.0
Feb. 10	-20.8	-5.7	-16.5	-0.7
23	-13.5	$+3.3$	-3.6	$+2.6$
1845, March 8	$-18''.4$	$+0''.3$	$+2''.9$	$+2''.3$

Sum of the squares of the errors in Elements I. = 8441″

" " " " " II. = 249″

The superiority of the new elements being manifest, it may be regarded as certain that the comets of 1556 and of 1844–45 were not different appearances of the same body.

FROM A LETTER OF PROFESSOR CURLEY TO THE EDITOR.

Georgetown College, D. C., July 11, 1850.

I SEND you the results of the few meridian observations of the comet, which we have yet obtained with our meridian-circle. There were difficulties in observing, on account of the very slight illumination which could be thrown on the threads without our losing sight of the comet, — as well as in getting the correct point of the comet's center. I have reason to think, however, that the observations are tolerably exact. The declinations are not corrected for parallax.

1850.	App. α h. m. s.	δ ° ′ ″
June 10	16 17 12.7	+71 17 55
12	16 2 25.0	70 16 0
13	15 55 25.0	69 39 54
16	15 35 1.5	67 35 3
18	15 22 27	65 53 54
19	15 16 26	64 57 29
21	15 5 6	62 53 24
24	14 49 40	+59 14 45

JAMES CURLEY, DIRECTOR OF THE OBSERVATORY.

LETTER FROM LIEUTENANT MAURY TO THE EDITOR.

Washington, July 15, 1850.

Parthenope has been observed here by Mr. Ferguson on five nights between the 11th and the 20th instant, with the filar-micrometer of the large equatorial. The observations, corrected for refraction, are as follows: —

1850.		No. of Obs	Comparison-Star.	Parthenope — Star $\Delta\alpha$	Parthenope — Star $\Delta\delta$	Parthenope's apparent α	Parthenope's apparent δ
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
July 11	10 10 32.4	4	Weisse XIV. 1016	—0 41.59	+4 27.80	14 53 29.98	—11 4 20.3
13	10 1 10.5	3	"	+0 1.24	—4 51.10	14 54 12.80	—11 13 39.2
14	8 48 44.8	9	"	+0 23.21	—9 20.16	14 54 34.77	—11 18 8.3
19	9 18 33.1	6	Weisse XIV. 1072	+0 11.39	+4 35.42	14 56 58.58	—11 43 47.7
20	9 46 49.2	5	"	+0 45.80	—0 50.05	14 57 32.99	—11 49 12.3

The adopted mean places of the stars of comparison were, —

	α	δ
	h. m. s.	° ′ ″
Weisse XIV. 1016	14 54 9.96	—11 8 47.88
" 1072	14 56 45.57	—11 48 22.65

The observations on the 11th are not very reliable. The planet resembles a star of the 10th magnitude.

M. F. MAURY.

COMET OBSERVATIONS.

Mr. Bond has communicated his latest observations of the comet now visible. They are referred to the mean equinox of 1850.0.

1850.	M. T. Cambridge.	α	δ	Comparisons.
	h. m. s.	h. m. s.	° ′ ″	
July 22	8 45 29	13 29 26.5	— 7 54 57	4 good ones with B. A. C. 4565.
23	8 21 9	13 27 53.9	—10 23 45	with *Spica*.
"	9 0 32	13 27 52.4	—10 27 40	9 in α and 3 in δ, with Weisse XIII. 397.

NOTICE.

The newly published Treatise on Plane and Spherical Trigonometry, by Professor Chauvenet, has induced me to depart from the ordinary rule of the *Astronomical Journal*, the province of which does not include notices of new works, except in extraordinary cases. Professor Chauvenet has endeavored to furnish a manual of Trigonometry which shall include the latest advances made in that department of mathematics, and be worthy of adoption as a standard. In this work he has rendered a service to good science. The consideration of the Gaussian formulas and of the "general spherical triangle," a full discussion of the Gaussian tables of Logarithms for addition and subtraction, and an elegant discussion of the differences and differentials of triangles, are among the improvements upon Cagnoli's treatise which the progress of science during the last forty years has enabled Professor Chauvenet to make.

G.

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THE

ASTRONOMICAL JOURNAL.

No. 14.

VOL. I. · CAMBRIDGE, AUGUST 9, 1850. NO. 14.

ON THE DETERMINATION OF THE VELOCITY OF THE GALVANIC CURRENT BY MEANS OF THE ELECTRO-CHEMICAL TELEGRAPH.

The following interesting report by Mr. Walker, on the continuation of his researches concerning the velocity of propagation of galvanic electricity through telegraph wires, has been communicated by Professor A. D. Bache, Superintendent of the U. S. Coast Survey, for publication in the *Astronomical Journal.* Any objections to Mr. Walker's results in No. 7 of this Journal, founded on the difficulty of determining the "armature-time," are now removed by the accordance with his former results of those which he has now obtained by using the chemical action of the current to record his signals.

G.

ON THE RECENT TELEGRAPH OPERATIONS OF THE U. S. COAST SURVEY.

By SEARS C. WALKER,

ASSISTANT U. S. COAST SURVEY.

Supplementary Report.

To PROFESSOR A. D. BACHE, LL. D.,

Superintendent United States Coast Survey.

In compliance with your instructions of December last, I have sought for the earliest opportunity of testing by the chemical telegraph the velocity of propagation of the hydro-galvanic waves indicated by our experiments with the Morse mechanical-telegraph lines.

I take pleasure in acknowledging the liberality of Marshall Lefferts, Esq., President of the Merchants' Line of Chemical Telegraphs, and of H. J. Rogers, Esq., Superintendent of the North American Chemical-Telegraph Company, in tendering to the Coast Survey the free use of their lines for this experiment.

On Monday, the 8th of July, I succeeded in making my first complete experiment with the chemical line from Boston to New York, on a circuit of 407 miles in length, 220 of which were of iron wire in the air, and 187 in the ground.

The battery at each end of the line was equivalent to twenty-five Grove's pint-cups. The platinum poles of both batteries were directed towards each other on the wires. Each signal-station used its own battery for recording and transmitting the marks, or discolorations of the paper previously moistened with a solution of ferrocyanate of potassa. In this process, Mr. Bain has availed himself of the use of the multiple connecting-wires for the same battery. At the signal or writing station there is a short circuit connecting the poles of the main battery; there is also the main or long telegraph-circuit, extending from Boston to New York, by iron wires in the air, and returning through the ground. The writing is effected with the *make-circuit key*, which at the same time closes the short circuit and connects the battery with the main circuit.

As there was no astronomical clock in connection with the line, and as the experiment did not require one, I used the method practised in the longitude operations of the Coast Survey in 1846, 1847, and 1848, viz. that of tapping at fixed intervals (in this case, of two seconds) on the make-circuit key, and thus graduating the chemical disc of paper at Boston and New York. At the former place, the graduating-marks were made by the short or branch circuit, and at New York by the main or trunk circuit.

The chief operator at the New York office, under the direction of Marshall Lefferts, Esq., imprinted in every third interval between the *marks* of the graduated scale three *short marks*, which were also recorded at both stations by the duplicate (short and long) junction-circuit. Every facility for this purpose was furnished by the courtesy of the officers, at both extremities of the line.

It is almost unnecessary to remark, that the displacement of the relative position of the New York marks on the Boston time-

scale, at the two stations, corresponds to the double time of propagation of the galvanic waves between them, and to the relative times of delay of the commencement or end of the chemical action, after the beginning or end of the galvanic wave reaches the receiving-station. These latter quantities in this experiment take the place of the similar delays in the time of the induction or waning of the magnetic force in the mechanical-telegraph lines.

The chief inconvenience of the latter, that of the inward armature-vibration time, disappears in the chemical experiment. This is a point of great importance in the telegraph operations of the Coast Survey, from the uniformity which it allows in the chemical marks and pauses.

I subjoin the durations of the chemical marks on the short circuit at the signal-station, and on the long circuit at the receiving-station.

No.	Signal-Station.	Duration of the Mark m'.	Receiving-Station.	Duration of the Mark m	Signal-Station Excess. $(m'-m.)$	No.	Signal-Station.	Duration of the Mark m'.	Receiving-Station.	Duration of the Mark m.	Signal-Station Excess. $(m'-m)$
		s.		s.	s.			s.		s.	s.
1	New York	0.20	Boston	0.20	0.00	27	New York	0.23	Boston	0.20	+0.03
2		.26		.26	0	28		.23		.20	+ .03
3		.24		.24	0	29		.23		.20	+ .03
4		.20		.20	0	30		.23		.22	+ .01
5		.36		.36	0	31	Boston	.24	New York	.24	0
6		.22		.26	— .04	32		.32		.32	0
7		.22		.20	+ .02	33		.20		.22	— .02
8		.22		.22	0	34		.24		.22	+ .02
9		.21		.18	+ .03	35		.34		.32	+ .02
10		.24		.24	0	36		.32		.34	— .02
11		.26		.21	+ .05	37		.28		.28	0
12		.25		.22	+ .03	38		.26		.26	0
13		.15		.20	— .05	39		.28		.25	+ .03
14		.18		.16	+ .02	40		.24		.24	0
15		.20		.17	+ .03	41		.29		.26	+ .03
16		.22		.20	+ .02	42		.36		.38	— .02
17		.15		.16	— .01	43		.39		.44	— .05
18		.24		.21	+ .03	44		.38		.38	0
19		.20		.20	0	45		.38		.38	0
20		.24		.22	+ .02	46		.34		.34	0
21		.22		.20	+ .02	47		.30		.28	.02
22		.22		.21	+ .01	48		.44		.44	0
23		.18		.15	+ .03	49		.37		.33	.04
24		.22		.20	+ .02	50		.37		.34	.03
25		.24		.22	+ .02	51	Boston	0.29	New York	0.32	—0.03
26	New York	0.22	Boston	0.20	+ .02	—					
						51		13.31		12.89	+0s.42
							Mean of 51 results		. . .		+0s.00712

If we take the chemical marks at the signal- and receiving-stations as indicative of the duration of the period of galvanic action at each, we find a contraction of the latter of $m'-m = 0.00712$.

From this experiment it appears that if the waves of galvanic action, or of pauses, vary at all from the short to the long circuit, the former are shortened and the latter lengthened by about the 140th part of a second for a circuit of 407 miles, at a distance of 187 miles on the ground pole from the battery. This discrepancy is so small, that it may be neglected in the chemical experiments for wave-time, and we may without sensible discrepancy use either the *make-make*, *make-break* scale, or the reverse. The following table contains the result of sixty-three experiments for the measurement of wave-time from Boston to New York, read on the two kinds of scale just mentioned: —

Chemical Experiment for Wave-Time, 1850, *July* 8, *on the Line from Boston to New York.*

No. of Experiment.	Make-make Scale.			Make-break Scale.		
	Boston Half Readings.	New York Half Readings.	Boston Half Excesses.	Boston Half Readings.	New York Half Readings.	Boston Half Excesses.
	s.	s.	s.	s.	s.	s.
1	+0.28	+0.28	0.00	+0.36	+0.35	+0.01
2	.43	.40	+ .03	.47	.47	0
3	.54	.54	0	.60	.60	0
4	.28	.27	+ .01	.35	.35	0
5	+0.39	+0.37	+0.02	+0.47	+0.45	+0.02

No. of Experiment.	Make-make Scale.			Make-break Scale.		
	Boston Half Readings.	New York Half Readings.	Boston Half Excesses.	Boston Half Readings.	New York Half Readings.	Boston Half Excesses.
	s.	s.	s.	s.	s.	s.
6	+0.51	+0.48	+0.03	+0.57	+0.55	+0.02
7	.34	.33	+ .01	.39	.39	0
8	.44	.45	— .01	.53	.52	+ .01
9	.57	.57	0	.65	.66	— .01
10	.28	.30	— .02	.41	.38	+ .03
11	.50	.47	+ .03	.60	.57	+ .03
12	.67	.65	+ .02	.79	.76	+ .03
13	.28	.27	+ .01	.37	.36	+ .01
14	.43	.42	+ .01	.52	.51	+ .01
15	.56	.57	— .01	.66	.65	+ .01
16	.36	.37	— .01	.47	.45	+ .02
17	.54	.54	0	.64	.63	+ .01
18	.73	.72	+ .01	.82	.80	+ .02
19	.27	.27	0	.37	.37	0
20	.46	.43	+ .03	.55	.53	+ .02
21	.63	.60	+ .03	.72	.70	+ .02
22	.33	.29	+ .04	.39	.37	+ .02
23	.48	.46	+ .02	.57	.53	+ .04
24	.64	.62	+ .02	.69	.67	+ .02
25	.32	.29	+ .03	.40	.40	0
26	.48	.46	+ .02	.57	.56	+ .01
27	.66	.66	0	.76	.76	0
28	.22	.21	+ .01	.31	.29	+ .02
29	.42	.38	+ .04	.49	.46	+ .03
30	.58	.54	+ .04	.66	.62	+ .04
31	.33	.31	+ .02	.43	.40	+ .03
32	.52	.50	+ .02	.61	.59	+ .02
33	.72	.69	+ .03	.80	.76	+ .04
34	.33	.31	+ .02	.43	.40	+ .03
35	.53	.49	+ .04	.62	.59	+ .03
36	.71	.67	+ .04	.80	.76	+ .04
37	.20	.22	— .02	.30	.30	0
38	.40	.39	+ .01	.48	.47	+ .01
39	.55	.54	+ .01	.63	.62	+ .01
40	.27	.25	+ .02	.34	.34	0
41	.43	.42	+ .01	.50	.51	— .01
42	.59	.60	— .01	.67	.70	— .03
43	.38	.35	+ .03	.46	.46	0
44	.55	.53	+ .02	.65	.63	+ .02
45	.74	.73	+ .01	.83	.83	0
46	.50	.48	+ .02	.58	.57	+ .01
47	.64	.63	+ .01	.73	.72	+ .01
48	.77	.76	+ .01	.83	.82	+ .01
49	.26	.24	+ .02	.32	.32	0
50	.42	.39	+ .03	.48	.50	— .02
51	.57	.56	+ .01	.64	.62	+ .02
52	.27	.25	+ .02	.35	.32	+ .03
53	.44	.42	+ .02	.53	.52	+ .01
54	.62	.62	0	.70	.68	+ .02
55	.22	.22	0	.29	.28	+ .01
56	.38	.36	+ .02	.47	.45	+ .02
57	.54	.52	+ .02	.62	.62	0
58	.43	.40	+ .03	.52	.50	+ .02
59	.62	.60	+ .02	.72	.69	+ .03
60	.82	.79	+ .03	.90	.88	+ .02
61	.30	.26	+ .04	.40	.38	+ .02
62	.48	.44	+ .04	.59	.56	+ .03
63	+0.67	+0.63	+0.04	+0.76	+0.72	+ .04
63	29s.82	28s.78	+1s.04	35s.13	34s.22	+0s.91
Means.	Wave-time for 187 miles*		+0s.0165	Wave-time for 187 miles*		+0s.0144
	Wave-space for 1s		11000	Wave-space for 1s		13000

*** Here we have by 63 measures, $m' - m = 0^s.0188 - 0^s.0320 = -0^s.0042$. The mean of this value of $m' - m$, and that of the former table, is $m' - m = +0^s.0015$, a quantity quite insensible.**

These experiments, sixty-three in number, indicate a displacement of the New York marks on the Boston time-scale of about one second for every twelve thousand miles.

The result is conformable to the average of all the Coast Survey experiments with the mechanical registers of the Morse telegraph lines. The conclusion announced in my former Report (*Astronomical Journal*, No. 7), that the quantities y, z, and u are insensible in the average of many results, is well sustained by the chemical experiment.

Here the relative times of waning of chemical action, η, and of its delay after the wave reaches the receiving station. ζ, take the place of the y and z of the mechanical experiment. The remaining source of error, u, or the relative time of the returning armature-vibration in the mechanical experiment, disappears altogether.

From the experiments of the Coast Survey with the chemical and mechanical registers at the same station, and on the same circuit, it appears that the mechanical exceed the chemical pauses by about the fifteenth part of a second. This is the average duration of the returning armature-vibration, U. The quantity U may be increased to the fifth part of a second, by lengthening the pass, increasing the tension of the spiral spring, and lessening that of the galvanic current. In practice, however, and in a good condition of the line for working, the relative quantity $u = U' - U$ has been insensible on the average. In fact, there is no change of adjustments in the short space of a second of time, and little or no change in the value of U, from change in the residual tension dependent upon the locality of the signal-station.

Still, this source of error in the mechanical experiments of the Coast Survey, made by a party of operators acting without previous concert, though it has not frustrated the general conclusions, has lessened the uniformity of the results, and furnished an occasion for objection to their soundness. The chemical experiment has the further advantage of avoiding the irregularity of action of the local battery and armature, and of the pressure of the graver.

In No. 7 of the *Astronomical Journal*, I have given the conditional equations for galvanic wave-time thus: —

$$\text{V.}\qquad \begin{aligned} 0 &= a\,x + y + B \\ 0 &= a\,x + z + M \\ 0 &= a\,x + \tfrac{1}{2}\,(y + z + u) + \tfrac{1}{2}\,(B + M). \end{aligned}$$

Make $\eta =$ the time of waning of the force of chemical action, after breaking the circuit, and $\zeta =$ the delay of commencement of chemical action, after closing the circuit. Then, since in the chemical experiment there is no return armature-time u, we have η in place of y, and ζ in place of z, using also β and μ in place of B and M,

$$\begin{aligned} 0 &= a\,x + \eta + \beta \\ 0 &= a\,x + \zeta + \mu \\ 0 &= a\,x + \tfrac{1}{2}\,(\eta + \zeta) + \tfrac{1}{2}\,(\beta + \mu). \end{aligned}\qquad \text{V.*}$$

Now since we find by this experiment $\beta = \mu$, very nearly, we have also, very nearly, $\eta = \zeta$, and the three equations of V.* are very nearly identical.

The experience of the Coast Survey, with circuits of various lengths from 400 to 1800 miles, with every variety of intervals between the signal and receiving stations, — of magnets, spiral springs, and armature adjustments, — of meteorological circumstances, — together with the chemical operations just described, may be summed up in a few words.

The six conditional equations of V. and V.* may take the form, —

$$\begin{aligned} 0 &= a\,X + B \\ 0 &= a\,X + M \\ 0 &= a\,X + \tfrac{1}{2}\,(B + M) \\ 0 &= a\,X + \beta \\ 0 &= a\,X + \mu \\ 0 &= a\,X + \tfrac{1}{2}\,(\beta + \mu). \end{aligned}\qquad \text{VI.}$$

Then these six new equations may all be satisfied very nearly with a constant value of X of $\frac{1}{12000}$ of a second. The small discrepancies from this average value on particular nights may be chiefly attributed to accidental irregularities. There are, however, some indications that the velocity of the current increases with the temperature. Leaving to a future occasion the discussion of this latter point, we may in general terms remark that

$$\begin{aligned} x &= \tfrac{1}{12000} - \frac{y}{a} \\ x &= \tfrac{1}{12000} - \frac{z + u}{a} \\ x &= \tfrac{1}{12000} - \tfrac{1}{2}\left(\frac{y + z + u}{a}\right) \\ x &= \tfrac{1}{12000} - \frac{\eta}{a} \\ x &= \tfrac{1}{12000} - \frac{\zeta}{a} \\ x &= \tfrac{1}{12000} - \tfrac{1}{2}\left(\frac{\eta + \zeta}{a}\right). \end{aligned}\qquad \text{VII.}$$

This general view of the subject shows either that the second terms in the second members of all these equations (VII.) are on the average insensible, or that they have a constant value under all the variety of circumstances above enumerated.

The latter alternative, of perfect equality of such heterogeneous quantities, must unquestionably be rejected.

SEARS C. WALKER,
Assistant U. S. Coast Survey.

Cambridge, *July* 10, 1850.

FROM LETTERS OF PROFESSOR SCHUMACHER TO THE EDITOR.

Altona, June 26, 1850.

The following elements of Petersen's comet have been computed by Sonntag and Götze, from normal places for May 4 and 22, and June 6: —

T	1850, July 23.58672, Greenwich.	
π	273° 25′ 13″.7	M. Equinox, 1850.0
☊	92 53 18.0	M. Equinox, 1850.0
i	68 13 19.3	
Log. q	0.0340853	
	Direct.	

The ephemeris computed from the elements to show its apparent path is in the next number [No. 721] of the *Astronomische Nachrichten*.

D'Arrest calculated from the totality of the observations, as soon as he received the series of meridian observations at Altona, the following elements, which will probably need but very slight corrections: —

T	1850, July 23.48002, Berlin.	
π	273° 23′ 47″.84	M. Equinox, 1850.0
☊	92 53 23.30	M. Equinox, 1850.0
i	68 10 36.93	
Log. q	0.0339176	
	Direct.	

The Altona meridian observations are strictly represented as follows: —

		$\Delta\alpha.\cos\delta$	$\Delta\delta$
(C. — O.)	May 25	+5″.5	—7″.7
	26	+2.2	+0.2
	28	—1.5	—0.3
	29	+5.2	—2.7
	May 30	+5″.8	—0″.7
	31	+4.1	+2.0
	June 1	+7.0	+0.1
	2	. . .	+0.3
	3	+1.0	—1.2
	5	+1.8	+2.3
	7	. . .	—5.9
	9	—0.9	+1.6
	10	+0.3	+2.2

My son Richard Schumacher has continued Sonntag's ephemeris from these elements.

Mean Berlin Noon.

1850.	α	δ	Log. r.	Log. Δ
Aug. 20	195° 5′.8	—50° 33′.2	0.0689	9.9627
24	194 37.3	53 32.3	0.0786	9.9939
28	194 15.7	56 12.7	0.0890	0.0227
Sept. 1	194 1.2	58 38.3	0.1000	0.0493
5	193 53.9	60 52.9	0.1114	0.0737
9	193 54.6	62 59.2	0.1232	0.0963
13	194 2.2	64 59.3	0.1352	0.1172
17	194 17.1	66 54.9	0.1474	0.1366
21	194 39.3	68 47.3	0.1596	0.1545
25	195 10.0	70 37.2	0.1717	0.1712
29	195 50.0	72 25.9	0.1839	0.1869
Oct. 3	196 39.9	—74 13.9	0.1959	0.2015

The comet will consequently be observable in the southern hemisphere throughout September. ..... It was discovered near the north pole, and disappears near the south pole.

Altona, July 12, 1850.

Professor Plantamour, in Geneva, has made the following observations of *Parthenope*: —

1850.	M. T. Geneva. h. m. s.	α	δ	No. Comp.
June 9	10 5 31	224° 21′ 6″.7	—9° 43′ 28″.0	4
10	10 1 52	224 12 42.2	43 45.0	4
16	9 40 15	223 30 51.3	48 31.3	1
18	9 39 53	20 16.8	51 20.3	4
19	10 5 4	15 33.0	9 52 59.2	4
23	10 48 13	0 50.6	10 0 59.6	2
	10 51 13	223 1 7.6	—10 1 2.8	2
June 24	9 47 17	222 58 28.5	—10° 3′ 14″.1	3
26	10 1 49	54 42.4	8 28.2	3
	10 23 2	54 40.5	8 21.5	3
30	9 44 2	52 32.6	20 17.1	4
	" "	52 37.0	20 20.1	4
	10 2 29	52 29.4	20 15.5	2
July 3	9 37 19	55 19.7	30 32.6	4
	" "	222 55 26.1	—10 30 36.7	4

H. C. SCHUMACHER.

OBSERVATIONS OF PETERSEN'S COMET, MADE AT THE CAMBRIDGE OBSERVATORY, 1850.

Date.	M. T. Cambridge.	☄ α Mean Equinox, 1850.0.	No. of Obs.	☄ δ Mean Equinox, 1850.0.	No. of Obs.	Comparison-Stars.
	h. m. s.	h. m. s.		° ′ ″		
May 29	11 30 7	17 46 9.6	1	+74 12 45	1	*a.*
29	11 52 52	17 46 3.8	2	74 12 30	1	*b.*
31	9 30	17 32 52	1	74 3	1	Approximate.
31	9 47 53			74 3 11	1	*a.*
June 1	9 38 51	17 25 42.8	6	73 56 10	3	*c.*
1	9 56 18	17 25 35.7	3	73 56 6	3	*b*, Instrumental comparisons.
3	10 5 14	17 10 50.4	2	73 36 21	2	*b*, " "
3	10 5 14	17 10 44.1	2	73 36 18	2	*d.*
4	11 11 35	17 2 55.1	4	73 22 56	2	*e.*
4	11 11 35	17 2 54.9	4	73 22 53	1	*f.*
6	9 40 45	16 48 7.3	4	72 52 5	3	*g.*
13	9 41 26	15 55 41.3	4			*h.*
13	9 41 26	15 55 42.1	4			*i.*
13	10 1 55			69 42 8	2	*h.*
13	10 1 55			69 42 7	2	*i.*
19	9 4 26	15 16 36.2	6			*k.*
19	9 8 29			64 58 44	3	*k.*
21	9 13 12	15 5 10.9	4	62 53 46	2	*l.*
26	9 44 18	14 40 9.7	6			*m.*
26	10 7 52			56 19 11	2	*m.*
July 4	10 4 2	14 9 50.0	8	41 12 27	4	*n.*
6	10 9 45	14 2 42.4	14	36 33 14	3	*o.*
6	11 36 48	14 2 31.2	6	36 24 14	2	*p.*
6	11 36 48	14 2 31.5	6	36 24 14	2	*q.*
8	8 58 26	13 58 19.5	3	31 26 12	2	*r.*
8	12 35 10	13 57 54.6	8	31 2 9	3	*s.*
9	8 53 4	13 55 42.1	8	28 45 39	5	*t.*
10	8 45 18	13 52 50.1	4	26 1 22	1	*u.*
10	9 10 0	13 53 8.6	12	25 58 32	4	*v.*
17	8 48 41	13 38 5.4	12	+ 5 47 0		*w.*
22	8 45 29	13 29 26.5	4	− 7 54 57	4	*x.*
23	8 21 9	13 27 53.9	3	10 23 46	1	*y.*
23	8 21 9	13 27 54.5	3	10 23 42	1	*z.*
23	9 0 32	13 27 52.4	9	10 27 40	3	*α.*
24	8 39 30	13 26 22.9	4	12 51 44	1	*β.*
24	9 6 23	13 26 20.6	8	12 54 33	2	*γ.*
25	8 58 5	13 24 54.0	4	−15 14 16	2	*δ.*

Mean Places for 1850.0 *of Comparison-Stars.*

	Star.	α	δ	Authority.
		h. m. s.	° ′ ″	
May 29	*a*	17 40 7.94	+74 5 21.7	H. C. 32630.
	a	17 40 6.97	74 5 16.1	Argel. Zone 126.
	b	17 36 50.29	74 19 1.9	B. A. C. 6001.
June 1	*c*	17 26 45.36	73 53 30.9	Determined July 23, from *c′*.
	c′	17 40 38.90	73 54 51.4	Argel. Zone 126.
3	*d*	17 4 29.87	73 31 5.0	Gr. 2420, from the Radcliffe Observations.
4	*e*	16 59 17.55	73 21 10.2	B. A. C. 5769.
4	*f*	17 3 34.24	73 24 12.0	Gr. 2481, from the Radcliffe Observations.
6	*g*	16 43 12.61	72 57 6.1	Argel. Zone 126.
13	*h*	15 59 32.23	+69 38 38.9	Argel. Zone 114.

	Star.	α	δ	Authority.
		h. m. s.	° ′ ″	
June 13	*i*	15 59 54.48	+69 39 18.9	Argel. Zone 114.
19	*k*	15 17 41.44	65 2 38.1	Determined July 24, from *k′*.
	k′	15 12 13.77	65 27 22.3	Argel. Zone 112.
21	*l*	15 17 9.52	63 0 48.3	Gr. 2224, from the Radcliffe Observations.
26	*m*	14 35 4.76	56 20 57.3	Argel. Zone 5.
July 4	*n*	14 10 21.24	41 5 58.9	B. Z. 472.
6	*o*	14 2 6.12	36 38 11.4	B. Z. 416.
6	*o*	14 2 6.19	36 38 28.1	B. Z. 466.
6	*o*	14 2 5.97	36 38 21.7	Determined July 23, from *p* and *q*.
6	*p*	14 5 31.09	36 25 30.1	B. Z. 466.
6	*q*	14 6 46.41	36 25 29.1	B. Z. 416.
6	*q*	14 6 46.49	36 25 33.6	B. Z. 466.
8	*r*	13 59 47.31	31 34 15.9	H. C. 25935.
8	*s*	13 56 10.83	31 3 17.6	H. C. 25828.
9	*t*	13 56 25.73	28 43 39.3	B. Z. 471.
10	*u*	13 54 18.37	26 5 12.8	B. Z. 462.
10	*v*	13 52 50.10	25 58 8.0	Compared with *u*.
17	*w*	13 38 35.33	5 52 17.5	H. C. 25380.
17	*w*	13 38 35.38	+ 5 52 10.1	B. Z. 83.
22	*x*	13 33 44.76	− 7 56 38.2	B. A. C. 4565.
23	*y*	13 17 17.73	10 22 36.6	α Virginis.
23	*z*	13 25 54.85	10 22 59.0	Weisse H. XIII. 430.
23	α	13 24 10.32	10 28 33.6	Weisse H. XIII. 397.
24	β	13 30 28.25	12 47 21.7	H. C. 25179.
24	γ	13 24 49.94	13 1 43.7	Weisse H. XIII. 412.
25	δ	13 19 27.71	15 11 43.0	B. A. C. 4494.
24	β	13 30 28.38	−12 47 24.4	Weisse H. XIII. 520.

REMARKS.

May 29. The comet has a decided stellar nucleus, so that its place relatively to the stars of comparison can be well determined. The right-ascension by the second observation is the most trustworthy.

May 31. The comet was seen for a few minutes through an opening in the clouds. There was no time to take the place of the star of comparison, which was supposed to be H. C. 32630.

June 1. By three comparisons with 29 Draconis, or B. A. C. 6001, at $9^{h.}\ 56^{m.}\ 18^{s.}$,

☄'s R A. $17^{h.}\ 25^{m.}\ 35^{s.}.7$
Dec. 73° 56′ 6″

taken with the circles of the equatorial.

The star *c* not having been found in the catalogues, its place was obtained from *c′*.

June 19. The star *k* is of the 10 magnitude, and its place given above depends upon the star *k′*.

June 26. The date of this observation was supplied from an ephemeris.

July 4. The nucleus as bright as a star of the 11 magnitude, but less than 1″ in diameter.

July 6. The declination of the star *o*, given in B. Z. 416, differs by 16″.7 from that in Zone 466. The mean of the two agrees nearly with our own place. This star has a companion of the 9.10 magnitude, distance 8″.6, position 210° 40′.

July 8. The nucleus is not so compact as on the previous evenings. The place from the star *s* may be somewhat better than that derived from *r*.

July 10. The R.A. of *u*, taken from B. Z. 462, has been increased by $1^{m.}$; *v* depends upon *u*.

The brightest part of the tail, which is now 5° long, seen in the comet-seeker, does not appear to lie in its axis; but a little to the north of it, where near the nucleus.

July 17. The star *w* is double, distance 1″ or 2″, position 60°. The comet has a fine star-like nucleus.

As the weather continues unfavorable, we shall not probably obtain a later place of the comet. The stars of comparison also, on the 26th and 29th, are too near the sun to be determined for the present season.

WM. CRANCH BOND.

Observatory, *Cambridge*, *July* 31, 1850.

OCCULTATIONS OF ALDEBARAN, JUPITER, AND REGULUS, OBSERVED AT THE CAMBRIDGE OBSERVATORY, IN 1848, 1849, AND 1850.

CAMBRIDGE MEAN TIME.

Feb 12, 1848, Immersion and Emersion of *Aldebaran*.

	h. m. s.	Observer.	
Im.	5 1 54.7	W. C. Bond,	Great Refractor.
	54.2	G. P. Bond,	5 ft. Equatorial.
Em.	5 34 29.3	W. C. Bond.	
	26.9	G. P. Bond.	

May 4, 1848, Immersion of *Aldebaran*.

	h. m. s.		
Im.	6 41 24.1	W. C. Bond,	Great Refractor.
	24.5	G. P. Bond,	5 ft. Equatorial.

July 15, 1849, Immersion and Emersion of *Aldebaran*.

	h. m. s.	
Im.	21 25 53.7	W. C. Bond.
	53.6	G. P. Bond.
	52.8	T. H. Safford.
Em.	22 39 38.0	W. C. Bond.

November 29, 1849, Immersion of *Aldebaran*.

	h. m. s.	
Im.	9 21 50.4	W. C. Bond.
	51.4	G. P. Bond.

January 23, 1850, Immersion and Emersion of *Aldebaran*.

	h. m. s.		
Im.	7 14 39.1	W. C. Bond,	Great Refractor.
	39.0	G. P. Bond,	42 inch Achromatic.
Em.	8 29 50.5	W. C. Bond.	
	50.0	G. P. Bond.	

February 26, 1850, Occultation of the planet *Jupiter* and his satellites, observed with the Great Equatorial by W. C. Bond.

	h. m. s.	
Im. 3d Satellite,	14 29 47.0	
" 2d "	14 32 16.0	
First Contact,	14 34 15.2	
Second "	14 35 55.0	The lunar mountains
Im. 1st Satellite,	14 36 21.8	finely projected upon
" 4th "	14 48 17.7	the disc of the planet.
Em. 3d Satellite,	15 35 32.0	
" 2d "	15 37 31.6	
Third Contact,	15 39 43.3	
Fourth "	15 41 22.1	
Em. 1st Satellite,	15 42 21.4	
" 4th "	15 53 15.1	

April 15, Immersion and Emersion of *Aldebaran*.

	h. m. s.	
Im.	2 1 52.7	W. C. Bond.
	52.2	G. P. Bond.
Em.	3 1 40.3	W. C. Bond.
	36.4	G. P. Bond.

Immersion and Emersion of *Regulus*.

	h. m. s.		
Im.	5 56 26.8	W. C. Bond,	Great Refractor, very good.
	26.6	G. P. Bond,	5 ft. Equatorial.
Em.	7 8 50.7	W. C. Bond,	Very good.
	52.2	G. P. Bond.	

The occultation of *Jupiter*, on the 26th of February, was exceedingly fine. At the Immersion, one of the largest of the lunar mountains appeared projected upon the disc of the planet.

A beautiful effect was produced at the Emersion, by the very narrow unilluminated strip of the moon's surface which was interposed between the planet and the bright border of the moon. The visible portions of the two bodies were within about 30″ of each other, but separated by the intense blackness of the unilluminated edge of the moon, from behind which the planet and his satellites were emerging. Taking into account the power of the telescope and the favorable state of the atmosphere, it was probably one of the most beautiful phenomena of the kind which was ever witnessed.

W. C. BOND.

Cambridge Observatory, *August* 2, 1850.

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A volume will consist of twenty-four numbers, with a table of contents and alphabetical index. The price of subscription is $ 5.00, payable in advance, which may be sent either to the Editor, to the Publishers, Messrs. JAMES MUNROE & Co., Cambridge and Boston, or, in England, to Mr. JOHN CHAPMAN, London. Subscribers in France and Germany are requested to state in what way they prefer to have the Journal sent them.

THE

ASTRONOMICAL JOURNAL.

No. 15.

VOL. I. CAMBRIDGE, SEPTEMBER 10, 1850. NO. 15.

OBSERVATIONS OF PARTHENOPE, AND OF PETERSEN'S COMET,

MADE AT THE HAMBURG OBSERVATORY.

By PROFESSOR CHARLES RÜMKER,

DIRECTOR OF THE OBSERVATORY.

PARTHENOPE.

1850.	M. T. Hamburg.	α	δ	Obs.
	h. m. s.	° ′ ″	° ′ ″	
May 27	11 40 8.7	226 40 37.5	—9 53 35.2	
28	10 41 34.4	28 30.1	52 4.2	Meridian-Circle.
29	10 36 49.6	16 15.0	50 30.6	" "
30	10 32 6.1	226 4 18.4	49 15.0	" "
31	10 27 23.1	225 52 32.5	47 59.0	" "
June 1	10 22 41.6	41 6.5	46 52.8	" "
2	10 18 0.1	29 55.8	45 58.2	" "
3	10 13 22.2	225 19 7.9	45 12.0	" "
7	9 54 58.8	224 39 6.0	43 26.9	
10	11 52 3	224 12 15.0	43 40.9	6 Comparisons.
13	11 31 37.3	223 49 35.2	9 45 32.6	13 "
26	11 16 41.1	222 55 0.0	10 8 35.3	
27	10 54 23.7	53 27.2	11 17.1	
30	10 42 46.3	222 52 30.9	—10 20 14.2	

PETERSEN'S COMET.

1850.	M. T. Hamburg.	☄ α	☄ δ	Obs.
	h. m. s.	° ′ ″	° ′ ″	
May 2	10 20 36	291 2 15.4	+71 18 55.6	4 Comparisons.
3	10 37 3.7	290 47 30.5	71 29 13.9	4 "
4	12 15 48.9	290 28 25.2	71 40 13.6	6 "
7	10 56 17.4	289 20 28.2	72 9 12.0	6 "
8	10 13 50.8	288 55 33.0	72 18 43.0	4 "
10	10 35 16.3	287 53 8.3	72 38 46.8	
12	11 36 48.1	286 38 13.0	72 56 38.3	
13	11 47 25.1	285 56 13.2	73 5 14.0	
14	13 27 48.9	285 8 36.2	73 14 27.3	
15	10 54 0.9	284 26 20.3	73 21 45.3	
18	11 36 0.4	281 40 49.2	73 44 30.3	3 Comparisons.
19	12 23 12.6	280 36 54.0	73 51 3.2	5 "
20	13 7 22.9	279 29 49.1	73 57 15.9	8 "
23	12 19 21.6	275 52 39.3	74 10 36.9	11 "
25	11 14 0.7	273 11 14.3	74 15 35.4	
28	12 26 46.2	268 31 25.6	74 15 56.1	
29	12 13 9.8	266 53 41.8	74 13 26.5	
30	11 43 13.5	265 13 48.8	74 9 39.4	
31	12 18 18.5	263 26 40.2	+74 4 11.0	

1850.	M. T. Hamburg.	⚘ α	⚘ δ	Obs.
	h. m. s.	° ′ ″	° ′ ″	
June 1	11 43 53.3	261 41 18.0	+73 57 16.6	
3	12 23 36.1	257 57 59.0	73 37 47.3	Meridian-Circle.
5	12 0 41.6	254 11 37.0	73 11 3.3	" "
7	11 58 56.5	250 22 50	72 35 34.6	
9	11 14 42.4	246 36 32.3	71 50 42.1	Meridian-Circle.
10	11 7 12.1	244 43 43.8	71 24 43.0	" "
13	10 29 44.3	239 16 44.5	68 48 57.0	" "
19	13 23 34.4	229 13 56.9	65 1 43.1	" "
20	11 36 23.6	227 52 50.3	64 6 20.4	" "
21	13 20 41.2	226 22 57.3	62 57 25.4	
22	12 1 52.7	225 5 30.3	61 52 53.1	
26	12 7 37.5	220 11 5.1	56 32 15.4	3 Comparisons.
27	11 38 55.0	219 6 37.0	55 1 23.0	5 "
30	10 25 15.0	216 7 11.0	+49 56 20.0	1 "

OBSERVATIONS OF HEBE,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant Maury, Director of the Observatory.

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Obs	Star of Comparison.	☿ — * Δα	☿ — * Δδ	☿'s apparent α	☿'s apparent δ
1850.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
Feb. 16	12 6 10.58	4	458, Weisse XIII.	+1 16.68	+ 4 56.49	13 28 28.61	+ 5 45 47.85
26	11 35 42.80	2	413, "	+1 47.14	+ 2 27.53	13 26 33.73	+ 7 9 47.00
		2	472, "	—1 10.32	— 6 56.61	13 26 33.73	+ 7 9 46.20
	12 25 40.61	3	413, "	+1 46.57	+ 2 36.59	13 26 33.16	+ 7 9 56.06
		3	472, "	—1 10.73	— 6 40.68	13 26 33.05	+ 7 10 2.13
March 4	11 11 10.00	8	365, "	+1 48.01	+ 7 36.89	13 24 16.55	+ 8 4 52.18
	11 24 26.84	4	370, "	+1 24.53	— 6 28.70	13 24 17.16	+ 8 4 53.59
	12 31 34.90	3	365, "	+1 46.61	+ 8 6.85	13 24 15.16	+ 8 5 22.14
		3	370, "	+1 23.26	— 6 1.74	13 24 15.89	+ 8 5 20.55
8	10 38 14.75	4	392, "	—1 35.26	— 6 58.23	13 22 19.76	+ 8 42 46.75
	12 3 23.00	5	392, "	—1 37.07	— 6 24.37	13 22 17.95	+ 8 43 20.38
10	10 11 20.34	12	331, "	+0 32.84	— 6 13.45	13 21 13.25	+ 9 4 50.39
11	9 58 8.62	10	331, "	—0 1.93	+ 3 24.01	13 20 38.51	+ 9 14 27.83
	10 26 41.05	6	331, "	—0 2.71	+ 3 35.09	13 20 37.71	+ 9 14 38.91
19	11 34 45.04	4	208, "	+2 36.59	—18 7.22	13 15 14.48	+10 29 23.89
	12 23 46.13	10	208, "	+2 35.14	—17 48.41	13 15 13.03	+10 29 42.70
28	12 15 8.04	20	104, "	+1 4.48	—16 25.67	13 8 7.95	+11 51 14.26
31	10 23 37.91	11	104, "	—1 22.84	+ 8 8.59	13 5 40.65	+12 15 48.69
	11 55 52.67	6	104, "	—1 26.61	+ 8 37.59	13 5 36.89	+12 16 17.69
		6	{ 69, Weisse XIII. 4423, B. A. C.	+0 30.89	— 4 53.24	13 5 37.53	+12 16 18.24
April 2	9 50 2.48	5	69, Weisse XIII.	—1 6.54	+10 23.34	13 4 0.14	+12 31 35.34
	11 6 56.25	14	69, "	—1 9.92	+10 50.63	13 3 56.63	+12 32 2.63
4	11 1 30.84	8	1054, Weisse XII.	+1 23.77	— 4 45.32	13 2 13.80	+12 47 24.21
	12 53 58.43	7	1054, "	+1 20.00	— 4 10.79	13 2 10.03	+12 47 58.74
6	9 51 40.33	8	1047, "	—0 4.26	+ 1 56.83	13 0 33.35	+13 1 40.82
	10 42 28.00	11	1047, "	—0 5.62	+ 2 10.83	13 0 32.00	+13 1 54.81

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	Ann. Prec.	δ	Ann. Prec.	Authority.
		h. m. s.	s.	° ′ ″	″	
458, Weisse XIII.	9	13 27 11.43	+3.021	+ 5 40 55.69	—18.621	Weisse's Catalogue.
413, "	9	13 24 45.86	3.006	7 7 25.32	18.699	" "
472, "	8	13 27 43.33	3.006	7 16 48.66	18.605	" "
365, "	6.7	13 22 28.88	3.004	7 57 21.64	18.777	" "
370, "	8	13 22 51.76	3.002	8 11 28.69	18.758	" "
392, "	9	13 23 54.09	2.996	8 49 51.33	18.725	" "
331, "	8	13 20 39.53	2.996	9 11 10.56	18.825	" "
208, "	9	13 12 36.79	2.991	10 47 37.94	19.057	" "
104, "	7	13 7 2.25	2.988	12 7 46.60	19.203	" "
69, "	7	13 5 5.40	2.989	12 21 18.00	19.251	" "
1054, Weisse XII.	9	13 0 48.77	2.990	12 52 15.59	19.352	" "
1047, "	9	13 0 36.35	+2.990	+12 59 50.09	—19.357	" "

A METHOD OF FINDING THE DISTANCE OF A COMET FROM THE EARTH.

By G. P. BOND.

A method of ascertaining approximately the distance of a comet from the earth occurred to me two or three years ago, by which the solution of this problem is attained at a small outlay of labor; but being apprehensive that the neglected terms would affect the result too much to allow it to be practically useful, I hesitated in employing it until I had considered this point with more attention. For this purpose, I have recently computed the effects which in ordinary cases will result from errors such as observations are commonly liable to. As these are not to be evaded by any degree of care on the part of the computer, or of exactness in his processes, they offer the means of estimating the degree of accuracy to which the theory must be carried, in order to represent the observations within the limits of their errors. The following is the process referred to.

Let t, t', and t'' denote the times of observation, $\tau = k\,(t'-t')$, $\tau' = k\,(t''-t)$, $\tau'' = k\,(t'-t)$, log. $k = 8.23558$, α and θ the right ascension and declination of the comet, $\odot$ and Θ those of the sun at the first observation, R the earth's radius-vector, and ϱ and r the distances of the comet from the earth and sun respectively, δ the angular distance of the comet from the sun, and z the angle included between ϱ and r. The same letters with a single and a double accent are used for the second and third observations.

(1) $$\text{Let } a = \frac{[\sin(\alpha''-\alpha')\tan\theta + \sin(\alpha-\alpha'')\tan\theta' + \sin(\alpha'-\alpha)\tan\theta'']\cos\theta'\,2\,R'^3}{[\sin(\alpha''-\odot')\tan\theta + \sin(\alpha-\alpha'')\tan\Theta' + \sin(\odot'-\alpha)\tan\theta'']\cos\Theta'\,\tau\tau''}.$$

Then will

(2) $$a = \frac{\sin z'}{\sin(\delta'+z')}\left(1-\frac{\sin^3 z'}{\sin^3\delta'}\right).$$

The angle z', which is the only unknown quantity in (2), may be found by trial, when a is known; we then have,

(3) $$\varrho' = \frac{\sin(\delta'+z')}{\sin z'}R' \qquad r' = \frac{\sin\delta'}{\sin z'}R'.$$

The numerator of a must be computed to seconds of arc. In the denominator, the angles are needed to minutes only.

In endeavouring to form some idea of the value of terms which may properly be left out of consideration, I have assumed that, as the method of Dr. Olbers seldom fails to give ϱ and ϱ'' within small limits, the terms rejected by him are not essential to an approximate solution. Also, that the error in ϱ or ϱ'' by that method, resulting from a given error in the observed places, is a fair standard for ascertaining whether a quantity may with safety be rejected or not.

In the following expressions, the angle θ is not restricted in its signification to declinations, but is used generally to denote the angle of elevation of the comet seen from the earth above the plane of any great circle.

$$\varrho\sin\theta = \varrho'\sin\theta' - b\,\tau'' + \frac{c}{1\,.\,2}\tau^{2} - \frac{d}{1\,.\,2\,.\,3}\tau'^3 +, \text{\&c.} \quad (4)$$

$$\varrho''\sin\theta'' = \varrho'\sin\theta + b\,\tau + \frac{c}{1\,.\,2}\tau^2 + \frac{d}{1\,.\,2\,.\,3}\tau^3 +, \text{\&c.} \quad (5)$$

Eliminating b we obtain, —

(6) $$\varrho'\sin\theta' = \frac{\tau}{\tau'}\varrho\sin\theta + \frac{\tau''}{\tau'}\varrho''\sin\theta' - \frac{\tau\tau''}{1\,.\,2}c + \frac{\tau\tau''(\tau''-\tau)}{1\,.\,2\,.\,3}d -, \text{\&c.}$$

Since c is the second differential coefficient of $\varrho' \sin \theta'$, the sun's attraction on the earth and comet being inversely as the squares of their distances from it, we have, —

$$(7) \qquad c = - R' \sin \Theta' \left(\frac{1}{R'^3} - \frac{1}{r'^3}\right) - \frac{\rho' \sin \theta'}{r'^3}.$$

If now we take for the plane of projection that which passes through the geocentric places of the sun and comet at the middle observation, then

$$\theta' = 0 \qquad \Theta' = 0 \qquad c = 0$$

And (6) becomes,

$$(8) \quad 0 = \frac{\tau}{\tau'} \varrho \sin \theta + \frac{\tau''}{\tau'} \varrho'' \sin \theta'' + \frac{\tau \tau'' (\tau'' - \tau)}{1.2.3} d —, \&c.$$

Omitting the last term, this equation becomes identical with that used by Dr. Olbers for the ratio of the curtate distances, as will appear by substituting for $\sin \theta$ and $\sin \theta''$ their values expressed in latitude and longitude.

It is evident from (7), that $d = \frac{dc}{d\tau}$ is a quantity of the order zero, so that the last term of (8) can be rejected only on account of the smallness of the coefficient $\frac{\tau \tau'' (\tau'' - \tau)}{1.2.3}$.

The base line, so to speak, upon which depend the elements of an orbit derived from three observed places at short intervals of time, is properly a small quantity of the second order only in τ, or the difference of two quantities of the first order, namely, the geocentric motion in the interval preceding and in that following the middle observation.

Thus from (8), when $\tau = \tau''$

$$\frac{\rho - \rho''}{\rho} = \frac{\sin \theta + \sin \theta''}{\sin \theta''}. \qquad (9)$$

Since $\varrho - \varrho''$ and $\sin \theta$ are small quantities of the order of τ' and τ, $\sin \theta + \sin \theta''$ must be of the order of $\tau' \tau$. The term rejected when $\tau'' - \tau$ is small is $\frac{\tau \tau' (\tau'' - \tau)}{1.2.3} \frac{d}{\rho \sin \theta'}$, which compared with that retained is of the order of

$$\frac{\tau \tau' (\tau'' - \tau)}{1.2.3} \frac{d}{(\rho - \rho'') \sin \theta''} \text{ or } \frac{\tau'' - \tau}{1.2.3}.$$

Hence, we conclude that in Olbers's method the error in ϱ resulting from the rejected term is of the same order with $\frac{\tau'' - \tau}{1.2.3}$.

From errors of observation θ and θ'' become $\theta + d\theta$ and $\theta'' + d\theta$, and (9) is liable to the error $\frac{2\,d\theta}{\theta}$. We may take $d\theta = 5''$ and $\theta = 1° \times (t' - t)$; then will

$$\frac{2\,d\theta}{\theta} = \frac{0.0055}{(t'' - t)}$$

Which compared with $\varrho - \varrho''$ is of the order of

$$\frac{0.323}{(t'' - t)^2}.$$

As an instance of the effect of this class of errors, I have computed $\frac{\rho - \rho''}{\rho}$ for the comet now visible (July, 1850), by observations on May 29, June 1, and June 3, and again with a change of 10″ in the middle observation.

By original observations, $\frac{\rho - \rho''}{\rho} = 0.07692$

With the alteration of 10″, " $= 0.08120$

ϱ determined by Olbers's method would in the first instance be $\varrho = 1.0170$. With the error of 10″, $\varrho = 1.0954$.

Error of ϱ from an error of 10″ in the middle observation, $= 0.0484$.

In the case cited, which is not an extreme one, the difference of the intervals was about one day, and the effect of the term neglected in the theory not one hundredth part of those resulting from the probable errors of observation.

If the above reasoning be correct, we must admit that, as a general rule, for intervals of less than ten days, (9) represents the observations within the limits of their errors, and that we may safely neglect for that time terms of the order of $\frac{\tau'' - \tau}{1.2.3}$ compared with ϱ.

We now proceed to the demonstration of (1) and (2).

Taking for the great circle of the plane of projection that which intersects the first and third observed places of the comet, we have, —

$$\theta = 0 \qquad \theta'' = 0.$$

And (6) becomes,

$$\varrho' \sin \theta' = - \frac{\tau \tau''}{1.2} c + \frac{\tau \tau'' (\tau'' - \tau)}{1.2.3} d —, \&c. \quad (10)$$

θ', which represents the deviation of the geocentric path of the comet from a great circle, is of the order of $\frac{\tau \tau''}{1.2}$. If, therefore, we reject the last term, the resulting error in ϱ' will be $\frac{\tau \tau'' (\tau'' - \tau)}{1.2.3} \frac{d}{\sin \theta'}$, which is of the order of $\frac{\tau'' - \tau}{1.2.3}$ compared with ϱ', and is, as above, insensible. For a similar reason, the last term in (7), being of the order of $\frac{\tau \tau''}{2\,r'^3}$, compared with the first term, may also be neglected. Therefore, from (7) and (10),

$$\varrho' = \frac{\tau \tau''}{2} \frac{R' \sin \Theta'}{\sin \theta'} \left(\frac{1}{R'^3} - \frac{1}{r'^3}\right). \qquad (11)$$

The ratio $\frac{\sin \Theta'}{\sin \theta'}$ may be expressed in terms of right-ascension and declination as follows : —

$$(12) \qquad \frac{\sin \Theta'}{\sin \theta'} = \frac{[\sin (a'' - \odot') \tan \theta + \sin (a - a'') \tan \Theta' + \sin (\odot' - a) \tan \theta''] \cos \Theta'}{[\sin (a'' - a') \tan \theta + \sin (a - a'') \tan \theta' + \sin (a' - a) \tan \theta''] \cos \theta'}.$$

Putting $a = \frac{\sin \theta'}{\sin \Theta'} \frac{2 R'^3}{\tau \tau''}$, we find from (11) and (3)

$$a = \frac{R'}{\rho'} \left(1 - \frac{R'^3}{r'^3}\right) = \frac{\sin z'}{\sin (\delta' + z')} \left(1 - \frac{\sin^3 z'}{\sin^3 \delta'}\right) \text{ as in (2).}$$

It will be noticed that (11) becomes indeterminate, as does also Olbers's method, when the geocentric path of the comet is directed towards the sun.

OBSERVATIONS OF ENCKE'S COMET,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant Maury, Director of the Observatory.

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Obs.	Star of Comparison.	☄ — * $\Delta\alpha$	☄ — * $\Delta\delta$	☄'s apparent α	☄'s apparent δ
1848.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
Sept. 1	15 37 35.5	5	*a*	+0 3.89	+ 7 7.02	3 30 37.78	+33 44 10.02
6	13 7 20.65	5	Bessel, Z. 508	—3 56.58	+ 6 49.47	3 42 57.94	+35 40 6.94
7	12 50 22.17	5	Bessel, Z. 508	—2 2.59	+ 1 32.57	3 45 40.96	+36 4 27.13
23	12 31 46.78	2	*b*	—1 31.35	+ 2 26.20		
24	12 47 50.56	2	*c*	—0 2.36	— 7 26.05		
		2	*d*	—1 23.21	+ 5 9.75		
25	11 26 16.17	5	α Aurigæ.	—4 19.72	— 5 25.39	5 1 12.02	+45 44 33.91
Oct. 5	13 6 21.44	4	Argel. Z. 169, 34	—2 38.70	+14 23.70	6 38 25.76	+52 4 28.11
18	13 47 53.22	5	*e*	+4 21.38	+ 4 22.56		
27	17 1 10.68	10	Bessel, Z. 503	—0 8.33	+ 2 4.05	12 19 48.30	+25 5 56.42
			Bessel, Z. 503	—2 30.77	— 4 34.25	12 19 49.72	+25 6 0.71
28	17 5 18.42	14	*f*	+0 36.11	+11 6.15		
30	16 56 30.17	10	*g*	+0 20.66	+13 58.83		
Nov. 2	17 26 55.98	4	*h*	—1 29.52	— 9 10.37		
5	18 30 11.46	5	*i*	—1 36.57	+ 0 29.92		
15	17 45 49.91	10	*k*	—0 7.97	—10 23.75		

The first three of these observations are by Professor Hubbard, the remainder by Mr. Ferguson.

Adopted Mean Places for 1848.0 *of Comparison-Stars.*

*	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
a	9	3 30 30.87	+33 56 59.83	Diff. from *o* Persei.
Bessel's Zones, 508	8.9	3 46 51.35	+35 33 22.02	Bessel's Zones.
" "	8	3 47 40.34	+36 2 59.00	" "
b	9	4 50 3	+44 24 7	
c	8	4 55 2	+45 15 0	
d	8 double	4 56 6	+45 2 5	
α Aurigæ	1	5 5 28.08	+45 50 11.90	Nautical Almanac.
Argel. Zones, 169, 34	8 double	6 41 0.70	+51 50 24.70	Argelander's Zones.
e	8	10 16 4	+45 2 5	
Bessel's Zones, 503	8.9	12 19 57.87	+25 4 4.63	Bessel's Zones.
" "	8	12 22 19.76	+25 10 47.05	Bessel's Zones.
f	7	12 27 5	+22 40 3	
g	8	12 42 7	+18 31 6	
h	9	13 3 7	+13 1 1	
i	9	13 20 2	+ 7 39 9	
k	9	14 2 5	— 6 9 7	

COMET

Mr. George P. Bond, assistant at the Cambridge Observatory, discovered a Comet last evening, between ten and eleven o'clock, in Camelopardalus. Its position, referred to the mean equinox of 1850.0, was

1850.	M. T. Cambridge.	α	δ
Aug. 29	$11^{h.}\ 9^{m.}\ 45^{s.}$	$3^{h.}\ 24^{m.}\ 49^{s}.7$	$+58°\ 0'\ 37''.9$

Hourly motion in α, $+28^{s}$. Hourly motion in δ, $+33''$.

Mr. Bond describes the Comet as being quite faint.

Cambridge, August 30, 1850.

G.

LETTERS OF MR. G. P. BOND TO THE EDITOR.

Cambridge Observatory, August 31, 1850.

On the evening of the 29th, I detected a faint telescopic comet in Camelopardalus, 10° north of *α Persei*. Its motion was towards the east, and mostly in right-ascension.

In the great refractor it presents a very feeble concentration of light towards the center, — so that it cannot, at present, be observed with great exactness. We have obtained the following positions with the micrometer, referred to equinox of 1850.0: —

1850.	M. T. Cambridge. h. m. s.	☄ α h. m. s.	☄ δ ° ′ ″
Aug. 29	11 9 45	3 24 49.67	+58 0 37.9
Aug. 30	9 44 43	3 35 45.69	+58 7 19.2

Both of the above positions depend on the star in Argelander's Zones, 57.

✳ α	✳ δ
$3^{h.}\ 22^{m.}\ 44^{s}.34$	$58°\ 4'\ 21''.3$

I inclose an ephemeris of *Parthenope* which T. H. Safford has computed for us, as we found that we could follow it much beyond that in the *Astronomische Nachrichten* 721.

September 9, 1850.

I send four additional observations of the comet with the rough elements which I have found.

1850.	M. T. Cambridge. h. m. s.	☄ α, 1850.0. h. m. s.	☄ δ, 1850.0. ° ′ ″
Aug. 31	8 23 19	3 47 20.86	+58 10 17.1
Sept. 2	10 0 38	4 14 43.20	58 1 24.0
3	10 17 38	4 29 4.09	57 47 39.3
8	14 33 0	5 49 5.06	+51 21 52.6

Elements.

Perihelion Passage,	Oct. 19.3677 Greenwich M. T.
Longitude of Ascending Node,	205° 53″
Longitude of Perihelion,	89 22
Inclination,	40 18
Perihelion Distance,	0.56418
	Motion Direct.

For the computed middle observation,

$\Delta\alpha \cos\delta = 56''$ $\Delta\delta = 3''$

G. P. BOND.

EPHEMERIS OF PARTHENOPE.

Computed for Greenwich Mean Noon, by T. H. Safford, Jr. from the elements of Mr. Luther, in the *Astr. Nachr.*, No. 720.

1850.	α h. m. s.	δ ° ′	Hourly Variation in α s.	Hourly Variation in δ ″	Log. δ
Aug. 31	15 39 13	−16 13.2	+3.5	−17	0.3568
Sept. 1	40 38	20.1	3.5	17	
2	42 3	27.0	3.5	17	0.3607
3	43 26	33.8	3.5	17	
4	44 49	40.6	3.5	17	0.3647
5	46 15	47.3	3.6	17	
6	47 43	16 54.0	3.7	16	0.3688
7	49 11	17 0.5	3.7	16	
8	15 50 40	−17 7.1	+3.7	−16	0.3729
Sept. 9	15 52 11	−17 13.7	+3.8	−16	
10	53 43	20.2	3.8	16	0.3770
11	55 16	26.7	3.9	16	
12	56 50	33.2	4.0	16	0.3812
13	15 58 25	39.7	4.0	16	
14	16 0 1	46.2	4.0	16	0.3853
15	1 38	52.6	4.1	16	
16	16 3 16	−17 59.1	+4.1	−16	0.3894

ELEMENTS AND EPHEMERIS OF IRIS, FOR 1851.

By E. SCHUBERT, Cambridge, Mass.

Communicated by Lieutenant C. H. Davis, Superintendent of the Nautical Almanac.

The perturbations from 1848, January 1.0, to 1851, October 1.0, give, when integrated

	δi	$\delta \Omega$	$\delta \varphi$	$\delta \pi$	$\delta \mu$	$\int \delta \mu$	δM
♃	−3″.48	− ′ 13″.82	+4′ 26″.21	−7′ 58″.67	+0″.15993	+2′ 2″.83	+6′ 31″.82
♄	+0.48	− 9.40	+ 5.37	+ 19.09	+0.00532	+ 10.12	− 24.32
♃ + ♄	−3.00	−5 23.22	+4 31.58	−7 39.58	+0.16525	+2 12.95	+6 7.50

and the following osculating elements: —

1851, October 1.0, M. T. Washington.

M	337° 18′ 9″.81		i	5° 28′ 14″.13
π	41 21 38.68	M. equinox, October 1.0.	φ	13 26 16.18
Ω	259 43 38.19		μ	963″.02925
			Log. a	0.3775781

Ephemeris for the Opposition, 1851.

12h. M. T. Wash'n.	⌓ α	⌓ δ	Log. r	Log. △	12h. M. T. Washington.	⌓ α	⌓ δ	Log. r	Log. △
	h. m. s.	° ′ ″				h. m. s.	° ′ ″		
Sept. 5	0 7 21.32	+12 32 33.9	0.289273	9.995664	☍ Sept. 25	23 52 17.76	+11 20 29.1	0.281141	9.962610
6	6 45.58	31 36.4	.288842	.993206	26	51 27.93	14 17.4	.280764	.961973
7	6 8.45	30 21.3	.288414	.990820	27	50 38.39	7 54.5	.280389	.961442
8	5 29.98	28 48.8	.287988	.988508	28	49 49.23	11 1 21.0	.280018	.961016
9	4 50.23	26 59.0	.287564	.986273	29	49 0.54	10 54 37.8	.279651	.960697
10	4 9.23	24 51.8	.287142	.984117	30	48 12.43	47 45.5	.279286	.960484
11	3 27.07	22 27.3	.286723	.982012	Oct. 1	47 25.00	40 44.9	.278924	.960376
12	2 43.82	19 45.6	.286306	.980050	2	46 38.34	33 36.8	.278565	.960373
13	1 59.53	16 47.0	.285892	.978143	3	45 52.56	26 22.0	.278210	.960475
14	1 14.27	13 31.4	.285481	.976324	4	45 7.73	19 1.2	.277858	.960680
15	0 0 28.15	9 59.1	.285073	.974594	5	44 23.95	11 35.1	.277510	.960989
16	23 59 41.23	6 10.4	.284667	.972956	6	43 41.30	10 4 4.7	.277165	.961400
17	58 53.58	12 2 5.5	.284264	.971411	7	42 59.87	9 56 30.7	.276822	.961911
18	58 5.31	11 57 41.7	.283861	.969961	8	42 19.72	48 54.0	.276483	.962522
19	57 16.50	53 8.4	.283467	.968609	9	41 40.94	41 15.1	.276148	.963231
20	56 27.24	48 16.9	.283072	.967355	10	41 3.60	33 34.9	.275817	.964038
21	55 37.64	43 10.7	.282680	.966201	11	40 27.76	25 51.2	.275489	.964940
22	54 47.78	37 50.3	.282291	.965148	12	39 53.49	18 13.6	.275164	.965936
23	53 57.78	32 16.2	.281904	.964198	13	39 20.84	10 34.0	.274843	.967024
24	23 53 7.74	+11 26 28.9	0.281521	9.963352	14	38 49.89	9 2 56.0	.274525	.968203
					15	23 38 20.71	+8 55 20.4	0.274212	9.969471

The observations are to be corrected for aberration and parallax before comparison with the ephemeris.

Opposition.

1851, Sept. 25, 17h. 51m. 32s.4 M. T. Washington.

Mean Longitude,	=	2° 45′ 18″.0
Geocentric Latitude,		+11 9 20.5
Heliocentric Latitude,		+ 5 18 27.8
Intensity of Light,		3.560

Approximate Ephemeris.

IRIS, 1851.

0h. M. T. Washington.	⊕ α	⊕ δ	Log. r	Log. Δ	0h. M. T. Washington.	⊕ α	⊕ δ	Log. r	Log. Δ
	h. m.	° ′				h. m.	° ′		
Jan. 0	18 44.0	—21 40.2	0.4087	0.5496	July 11	23 55.6	+7 16.1	0.3165	0.1867
8	18 59.2	21 14.3	.4055	.5470	19	0 2.2	8 32.0	.3124	.1584
16	19 14.5	20 42.1	.4023	.5433	27	0 7.4	9 41.0	.3084	.1296
24	19 29.8	20 4.4	.3990	.5384	Aug. 4	0 11.1	10 41.5	.3044	.1006
Feb. 1	19 45.1	19 21.1	.3956	.5325	12	0 13.1	11 31.1	.3005	.0720
9	20 0.2	18 31.9	.3922	.5255	20	0 13.2	12 8.0	.2967	.0446
17	20 15.2	17 37.0	.3887	.5173	28	0 11.4	12 29.3	.2930	0.0191
25	20 30.0	16 36.4	.3851	.5082	Sept. 5	0 7.6	12 33.0	.2895	9.9967
March 5	20 44.7	15 31.0	.3814	.4981	13	0 2.4	12 18.2	.2861	.9791
13	20 59.2	14 21.8	.3777	.4868	21	23 56.0	11 45.5	.2829	.9667
21	21 13.5	13 8.5	.3739	.4745	29	23 49.4	10 57.9	.2799	.9609
29	21 27.6	11 50.7	.3700	.4612	Oct. 7	23 43.4	10 0.5	.2770	.9616
April 6	21 41.4	10 29.3	.3661	.4466	15	23 38.6	8 59.3	.2744	.9688
14	21 54.9	9 4.9	.3621	.4311	23	23 35.8	8 1.2	.2720	.9814
22	22 8.1	7 37.9	.3581	.4144	31	23 35.1	7 11.1	.2698	9.9990
30	22 21.0	6 8.8	.3540	.3967	Nov. 8	23 36.9	6 33.6	.2679	0.0197
May 8	22 33.6	4 38.0	.3499	.3779	16	23 41.0	6 10.4	.2664	.0424
16	22 45.8	3 6.0	.3458	.3579	24	23 47.1	6 2.1	.2651	.0664
24	22 57.6	1 33.5	.3416	.3368	Dec. 2	23 55.2	6 7.8	.2640	.0911
June 1	23 8.8	—0 1.1	.3374	.3145	10	0 4.9	6 27.8	.2633	.1157
9	23 19.6	+1 30.7	.3332	.2911	18	0 16.2	6 58.9	.2628	.1402
17	23 29.8	3 1.2	.3290	.2666	26	0 28.6	7 40.6	.2627	.1640
25	23 39.3	4 29.5	.3248	.2410	34	0 42.1	+8 32.4	0.2630	0.1867
July 3	23 48.0	+5 54.8	0.3207	0.2143					

This approximate ephemeris is calculated with the opposition-elements without any alteration.

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ADVERTISEMENT.

Communications for the Astronomical Journal will be addressed to the Editor, B. A. Gould, Jr., Cambridge, Mass.

A volume will consist of twenty-four numbers, with a table of contents and alphabetical index. The price of subscription is $ 5.00, payable in advance, which may be sent either to the Editor, to the Publishers, Messrs. James Munroe & Co., Cambridge and Boston, or, in England, to Mr. John Chapman, London. Subscribers in France and Germany are requested to state in what way they prefer to have the Journal sent them.

THE

ASTRONOMICAL JOURNAL.

No. 16.

VOL. I. CAMBRIDGE, SEPTEMBER 30, 1850. NO. 16.

ON THE RIGHT-ASCENSION OF α VIRGINIS.

By E. SCHUBERT.

Communicated by Lieutenant C. H. DAVIS, Superintendent of the Nautical Almanac.

ON the 1st of February of the present year I was charged by Lieutenant DAVIS, Superintendent of the Nautical Almanac, with an entirely new reduction of the observations of *Mars* made at Greenwich by BRADLEY, BLISS, and MASKELYNE, using the greatest care and circumspection, in order to discover and correct any incidental errors in the reductions already made at Greenwich, as these observations were to be used in the construction of new tables of *Mars* in the preparation of the Almanac. By the beginning of April I had completed the right-ascensions up to the year 1802. In the course of this work, I was struck with the fact that the clock-errors given by *α Virginis* differed everywhere from those given by other fundamental stars in such a manner that the right-ascension of *α Virginis* given by the *Tabulæ Regiomontanæ* appeared to be too great. I called Lieutenant DAVIS's attention to this circumstance. He himself, as well as Professor PEIRCE, immediately pronounced the subject to be worthy of the more particular investigation which I had suggested. On the 8th of April I was formally directed to commence this. I have discharged this commission in the following manner.

I made, in the first place, comparisons at different times and with various fundamental stars, as will be hereafter seen, and found my supposition confirmed. For the principal comparison I selected only stars whose right-ascensions have been determined very exactly by BESSEL from the observations of BRADLEY, viz. *β Orionis*, *α Orionis*, *α Canis majoris*, *α Canis minoris*, and *α Aquilæ*. I decided afterwards to omit *α Canis majoris*, because that star also showed deviations. Upon mentioning to Professor PEIRCE my supposition of a change in the proper motion of *α Virginis*, he immediately reminded me that BESSEL had already made a precisely similar supposition in the case of the former star (*α Canis majoris.*)

The following comparisons of *α Virginis* with various fundamental stars, and at different times, were made in the first instance for the purpose of farther inquiry as to whether the supposition I had already made might prove well founded or not.

The clock-errors given by the comparison-stars are reduced to the transit-time of *α Virginis*. The comparison-stars are arranged in the order of their declinations.

PRELIMINARY COMPARISONS.

Year and Day of Observation.	Stars.	Seconds of Tab. R.A	Seconds of True Transit.	Used Hourly Clock-Rate.	Clock-Errors.	Mean.	*α Virginis* minus Mean.
		s.	s.	s.	m. s.	m. s.	s.
1751, June 18	α Boötis	21.641	54.950	+0.0443	+1 33.269		
	α Canis Min.	16.403	49.524		.378	+1 33.324	
	α Virginis	9.602	42.732		.130		−0.194
1752, March 29	α Aquilæ	42.038	44.430	+0.0996	+1 1.784		
	β Orionis	38.772	39.867		.912	+1 1.848	
	α Virginis	12.692	14.460		.768		−0.080
1778, January 19	α Orionis	9.770	43.968	+0.0232	+0 34.372		
	α Serpentis	19.390	53.878		.435		
	β Orionis	52.845	27.242		.587		
	2α Libræ	36.629	11.162		.501		

Year and Day of Observation.	Stars.	Seconds of Tab. R A.	Seconds of True Transit.	Used Hourly Clock Rate.	Clock-Errors.	Mean.	*α Virginis* minus Mean.	
		s.	s	s.	m. s.	m. s.	s.	
1778, January 19	α Scorpii	47.840	22.326		+0 34.416	+0 34.462		
	α Virginis	30.833	5.142		.309		—0.153	
1778, May 12	α Serpentis	22.039	37.282	+0.0025	+1 15.237			
	α Canis Min.	39.500	54.642		.157			
	β Virginis	8.579	23.820		.245			
	α Hydræ	40.499	55.582		.093			
	α Scorpii	51.050	6.307		.250	+1 15.197		
	α Virginis	32.473	47.562		.089		—0.108	
1782, June 25	α Serpentis	34.802	47.762	—0.0135	+0 12.991			
	β Aquilæ	38.631	51.560		13.017			
	α Canis Min.	52.857	5.862		12.927			
	α Hydræ	52.624	5.482		12.805			
	2α Libræ	52.985	6.020		13.054			
	α Scorpii	6.932	19.766		12.875	+0 12.945		
	α Virginis	45.520	58.302		12.782		—0.163	
1782, July 23–24	α Serpentis	34.622	34.228	—0.0222	+0 0.343			
	β Aquilæ	39.014	38.400		.470			
	α Canis Min.	53.170	52.742		.557			
	β Orionis	4.654	4.355		.481			
	1α Capricorni	36.286	35.544		.589			
	2α Capricorni	59.925	59.205		.567			
	2α Libræ	52.755	52.302		.422	—0 0.490		
	α Virginis	45.249	44.782		.467		+0.023	
1783, May 20	α Aquarii	39.329	58.508	—0.0201	+0 19.334			
	β Orionis	6.822	26.544		.557			
	2α Capricorni	4.146	21.423		.416			
	1α Libræ	45.346	5.004		.686			
	2α Libræ	56.736	16.282		.574	+0 19.513		
	α Virginis	49.199	8.662		.463		—0.050	
1792, July 27–28	α Boötis	12.091	8.120	—0.0180	—0 3(.954)			$\delta = 20°.3$ North.
	α Leonis	17.260	13.478		.841			
	α Orionis	55.725	52.147		.713			
	α Serpentis	4.072	0.182		.849			
	β Orionis	33.612	29.982		.778			
	α Scorpii	43.762	40.038		.670	—0 3.770		
	α Virginis	16.945	13.102		.843		—0.073	
	α Canis Maj.	59.115	55.818		.416		+0.354	= *α Can. Maj.*— Mean.
1794, July 3–4	α Leonis	23.074	4.074	—0.0110	+0 40.964			
	α Orionis	1.037	42.042		.923			
	α Serpentis	9.603	50.410		.832			
	β Orionis	38.227	19.282		40.965			
	2α Libræ	32.194	13.182		41.003	+0 40.937		
	α Virginis	22.831	3.602		40.771		—0.166	
	α Canis Maj.	3.483	44.853		41.297		+0.360	= *α Can. Maj.*— Mean.
1800, May 6	α Leonis	43.305	48.862	—0.0029	+0 5.547			
	α Canis Min.	49.463	54.964		.484			
	β Virginis	17.980	23.460		.475			
	α Hydræ	45.940	51.564		.612			
	β Orionis	55.236	0.804		.544	+0 5.532		
	α Virginis	42.102	47.483		.381		—0.151	
1800, July 12	γ Pegasi	58.674	17.055	+0.0066	+0 18.468			
	α Serpentis	27.584	46.084		.485			
	α Scorpii	12.513	31.030		.497	+0 18.483		
	α Virginis	41.736	0.055		.319		—0.164	

FINAL COMPARISONS.

Year and Day of Observation.	α Virginis minus Mean.	α Virginis minus β Orionis.
	s.	s.
1764, January 3	—0.200	—0.200
21	—0.296	—0.329
Feb. 11	—0.177	—0.247
May 27	—0.020	
June 20	+0.092	
1767, Feb. 22	—0.034	—0.111
Dec. 17	—0.046	—0.046
1768, April 2	—0.036	—0.036
3	—0.082	—0.050
4	—0.211	
5	—0.085	—0.023
June 4	—0.206	
30	(—0.585	—0.626)
July 1–2	—0.206	
Mean	—0.116	—0.130
	—0.123	
1769, Feb. 24	—0.113	—0.113
Nov. 14	(—0.456	—0.456)
1770, January 17	—0.154	—0.290
May 15	—0.351	
1771, January 6	+0.096	+0.096
June 29	—0 139	
Aug. 20-21	(—0.395	—0.435)
Aug. 30-31	—0.276	—0.242
Dec. 17	—0.055	—0.055
27	—0.204	—0.276
29	—0.207	—0.207
Mean	—0.156	—0.155
	—0.156	
1772, March 20	—0.153	
July 22–23	—0.156	—0.156
Dec. 10	—0.065	—0.065
1773, Feb. 10	—0.241	—0.241
11	(+0.140	+0.140)
March 11	+0.026	+0.018
13	—0.125	—0.076
May 30	—0.058	—0.022
June 1	—0.208	—0.314
July 14–15	—0.057	+0.006
Mean	—0.115	—0.106
	—0.111	
1774, March 28	(—0.482	—0.406)
May 10	—0.128	—0.128
Aug. 1–2	—0.231	—0.315
Dec. 29	(+0.137)	+0.059
1776, May 21	—0.156	
22	—0.023	
July 24–25	—0.208	—0.208
25–26	(+0.168	+0.168)
Aug. 1–2	—0.208	
9–10	—0.103	
Mean	—0.151	—0.148
	—0.150	

Year and Day of Observation.	α Virginis minus Mean.	α Virginis minus β Orionis
	s.	s.
1777, January 28	—0.341	—0.245
29	—0.231	
Feb. 24	—0.122	—0.046
March 24	+0.093	+0.082
25	—0.070	—0.123
26	—0.099	—0.231
May 18	—0.029	—0.029
25	—0.165	—0.058
27	—0.098	—0.098
June 4	—0.103	
Aug. 10-11	—0.094	
14–15	+0.009	
Sept. 24-25	—0.081	
Mean	—0.102	—0.093
	—0.098	
1778, January 19	—0.175	—0.083
April 9	—0.151	—0.055
10	—0.231	—0.245
11	—0.270	—0.154
June 7	(+0.109)	
12	+0.044	
July 17–18	—0.018	—0.018
26–27	—0.057	
Aug. 17–18	—0.090	—0.206
24–25	—0.057	—0.128
Mean	—0.112	—0.127
	—0.120	
1779, March 5	(+0.095	+0.109)
April 2	+0.006	+0.006
May 23	—0.020	—0.020
1780, Feb. 23	—0.060	+0.022
April 17	—0.101	
May 20	—0.029	—0.059
21	—0.094	
27	(—0.365	—0.448)
July 16–17	—0.078	—0.020
23–24	+0.039	+0.039
Aug. 2–3	—0.121	—0.133
3–4	—0.151	—0.120
1781, April 29	—0.073	
May 23	—0.165	—0.165
Mean	—0.071	—0.050
	—0.061	
1782, March 29	—0.226	(—0.258)
April 20	—0.012	
22	—0.035	
June 15–16	—0.123	—0.052
16–17	+0.029	+0.020
20–21	+0.111	+0.028
21–22	—0.017	—0.065
22–23	+0.048	—0.033
24–25	—0.178	—0.156
25–26	+0.101	+0.093
July 21–22	+0.046	+0.046
22–23	—0.087	—0.087
Mean	—0.028	—0.023
	—0.026	

Year and Day of Observation.	α Virginis minus Mean.	α Virginis minus β Orionis.
	s.	s.
1783, January 23	—0.067	—0.084
Feb. 19	(—0.177	—0.222)
April 16	+0.029	
17	—0.154	
May 10	—0.157	
12	—0.063	—0.067
20	—0.094	—0.094
21	+0.073	+0.073
July 7–8	—0.017	—0.058
8–9	+0.006	+0.008
27–28	—0.023	
28–29	—0.101	
Dec. 18	—0.126	—0.126
Mean	—0.058	—0.050
	—0.054	
1784, Feb. 10	+0.064	+0.077
May 3	+0.080	+0.051
5	—0.046	—0.046
7	—0.012	—0 012
9	—0.030	—0.115
June 2	—0.053	—0.053
5	—0.046	
July 4	—0.064	—0.072
Sept. 5–6	—0.054	—0 059
1785, Jan. 31	+0.052	+0.084
May 18	—0.059	—0.059
June 16–17	—0.023	—0.127
25–26	—0.115	(—0.217)
30–31	—0.027	—0.027
July 12–13	—0.012	—0.012
29–30	+0.018	
Mean	—0.020	—0.029
	—0.025	
1786, May 6	—0.133	—0.178
11	—0.032	—0.032
15	—0.007	—0.034
June 8–9	—0.016	—0.142
1787, May 13	—0.066	—0.075
14	—0.224	(—0.397)
16	+0.032	(+0.092)
18	—0.095	—0.016
27	—0.187	—0.187
Aug. 1–2	—0.209	
Mean	—0.094	—0.095
	—0.095	
1788, April 20	—0.234	
June 8–9	—0.085	—0.116
July 3–4	—0.300	
Aug. 2–3	—0.226	—0.300
17–18	—0.055	+0.076
1789, April 10	—0.106	—0.014
18	—0.246	—0.147
May 8	(—0.419)	
July 17–18	+0.041	—0.004
18–19	—0.187	—0.185
Mean	—0.155	—0.099
	—0.127	

Year and Day of Observation.	α Virginis minus Mean.	α Virginis minus β Orionis.
	s.	s.
1790, March 31	—0.110	—0.203
June 20–21	—0.028	—0.121
July 18–19	+0.022	+0.054
Dec. 21	—0.141	—0.150
1791, March 21	—0.154	—0.227
May 26	—0.082	—0.290
28	+0.071	
June 26–27	+0.022	+0.022
July 4–5	+0.004	+0.050
5–6	—0.333	—0.333
15–16	—0.087	—0.046
1792, March 11	—0.010	+0.008
April 25	+0.101	—0.055
July 27–28	—0.097	—0.065
Mean	—0.059	—0.104
	—0.082	
1794, May 12	—0.247	
27–28	—0.137	—0.316
July 3–4	—0.173	—0.194
5–6	(+0.258	+0.248)
7–8	+0.038	+0.152
Aug. 11–12	—0.024	—0.154
12–13	—0.105	—0.132
1795, Feb. 5	+0.005	—0.170
May 7	—0.320	
18	—0.174	—0.231
19	—0.360	—0.308
23	—0.235	—0.320
Aug. 17–18	—0.034	—0.147
Mean	—0.147	—0.182
	—0.165	

Year and Day of Observation.	α Virginis minus Mean.	α Virginis minus β Orionis.
	s.	s.
1796, May 17	—0.073	—0.062
19	—0.040	—0.036
Aug. 6–7	—0.098	—0.065
1797, Feb. 15	—0.072	—0.072
June 5	—0.055	—0.103
July 13–14	—0.126	—0.219
Aug. 7–8	—0.066	—0.013
1798, April 28	—0.118	—0.150
June 15–16	—0.132	—0.132
Mean	—0.087	—0.095
	—0.091	
1799, Feb. 22	—0.059	—0.059
May 16	—0.072	—0.176
28	—0.043	—0.057
29	—0.149	—0.236
1800, May 6	—0.133	—0.163
July 23–24	—0.216	—0.216
Aug. 2–3	—0.024	—0.100
Mean	—0.099	—0.144
	—0.122	
1801, April 26	—0.162	—0.171
27	—0.113	—0.187
29	—0.180	—0.163
1802, March 4	—0.105	—0.266
May 1	—0.162	
4	—0.067	—0.005
7	—0.040	—0.057
11	—0.129	—0.127
Mean	—0.120	—0.139
	—0.130	

The results of the comparisons with the four fundamental stars above mentioned are as follows. On this point, however, we have only to premise, that *α Aquilæ* has been used in but a few instances as a star of comparison, and that the means have been taken out in such a manner as to give the greatest influence to *β Orionis*, because its declination differs but little from that of *α Virginis*. For the means of the times I have simply given the corresponding mean values, in order to exhibit a remarkable peculiarity of the signs of the differences.

MEAN VALUES OF FINAL COMPARISONS.

1766	s. —0.123				13 = No. Compar.			s. —0.040	1784	+	
		s. —0.140	1768	—		1785	s. —0.025			+	16 = No. Compar.
1770	0.156			—	9			0.060	1786	—	
		0.134	1771.5	+		1787	0.095			—	10
1773	0.111			+	9			0.111	1788	—	
		0.131	1774	—		1789	0.127			—	9
1775	0.150			—	7			0.105	1790	+	
		0.124	1776	+		1791	0.082			+	14
1777.5	0.098			+	13			0.124	1793	—	
		0.109	1778	—		1795	0.165			—	12
1778.5	0.120			—	9			0.128	1796	+	
		0.091	1779	+		1797	0.091			+	9
1780	0.061			+	12			0.107	1798.5	—	
		0.044	1781	+		1800	0.122			—	7
1782.5	0.026			+	12			—0.126	1801	—	
		—0.040	1783	—		1802	—0.130			—	8
1783.5	—0.054			—	12						181 = Sum.

1811—1814 —0.097 from 8 comparisons.

In this table, then, the decrease of the differences until about the year 1783 is distinctly appreciable, as well as their increase afterwards in nearly the same ratio. This diminution of the differences up to the year 1783, and the subsequent decrease, correspond to an increase of the relative right-ascension, and to a subsequent decrease of it. I think it thus placed beyond all doubt that there are *variations in the proper motion of α Virginis.* The comparison-stars, for the most part, agree very well with one another, and in the few exceptions the error is balanced by the change of signs. Imperfections in the application of the instrument, and its accidental errors, can have had but little influence, since the question here is only of differences.

Bessel has given already a similar comparison of *Sirius* in Vol. XXII. of the *Astronomische Nachrichten*, in which a continual increase of the relative right-ascension of *Sirius* appears during all the years given in the above table, as far as 1794, where the difference is at the maximum. Bessel is somewhat distrustful of the result, and particularly of the maximum, because at that time the instrument was not in a perfect condition. This imperfection may have influenced in some measure the quantity of the individual results, but certainly not the character of the whole.

This new case of *α Virginis* confirms in the most striking manner the truth of Bessel's result. The results obtained for the two stars during the years in the foregoing table are widely different in character, although the stars of comparison are the same. The right-ascension of *α Virginis* increases till about 1783, and then continually decreases; the values for the years in which the instrument was not in a perfect condition exhibit throughout no remarkable deviation from the law of progress. The right-ascension of *Sirius*, on the contrary, is increasing through all the years as far as 1794.

Let us now examine somewhat more closely the comparisons made in 1792 and 1794. In 1792, July 27–28, the five stars of comparison from *α Leonis* ($\delta = +13°$) to *α Scorpii* ($\delta = -26°$) agree very well, in spite of the imperfections of the instrument. *α Virginis* ($\delta = -10°$), and *α Canis majoris* ($\delta = -16°$), lie in declination between *β Orionis* ($\delta = -8°$), and *α Scorpii* ($\delta = -26°$). *α Virginis* gives a difference from the mean of the comparison-stars $= -0^s.073$, and *α Canis majoris* a difference $= +0^s.354$. Or, if we take the mean only of *β Orionis* and *α Scorpii*, of $\left.\begin{matrix}-3^s.778\\-3^s.670\end{matrix}\right\} = -3^s.724$, then the differences are respectively $-0^s.119$ and $+0^s.308$; so that the instrument would have given the right-ascension of *α Virginis* too small, and that of *Sirius* too great, although both lie between stars which agree very well. The difference of $0^s.108$ between the two including stars proceeds, probably, from an error of azimuth, as a glance at the first table will show. In 1794, July 3–4, the five comparison-stars from *α Leonis* ($\delta = +13°$) to *2α Libræ* ($\delta = -15°$) agree still better than before. The difference of *α Virginis* from the mean $= -0^s.166$, and that of *α Canis majoris* $= +0^s.340$; or *α Virginis* minus *β Orionis* $= -0^s.194$, and *α Canis majoris* minus *2α Libræ* $= +0^s.294$, while *2α Libræ* minus *β Orionis* $= +0^s.038$. This shows satisfactorily how little is to be feared for the main result on the part of the instrument.

Let us still look at the matter from another point of view. Bessel determined the right-ascension of *α Virginis* from fourteen observations of Bradley, by direct comparison with the sun, and found it to be (for the year 1755) $= 13^h\ 12^m\ 19^s.045$. He substituted, however, for the mean right-ascension thus obtained, a different one of $19^s.180$, because he believed the former, on account of the small number of observations, not to be sufficiently exact. But we must now take this first direct determination as the right one, since it agrees very well with the results above found. The difference between this and the substituted right-ascension $= -0^s.135$. Bessel calculated the mean right-ascensions in the *Tabulæ Regiomontanæ* by means of the values assumed for 1755 and 1825, according to the formula,

$$\text{R.A. for } 1750 + t = \alpha + (\alpha' - \alpha)\,\frac{t-5}{70} + \Delta p\,\frac{(t-5)(t-75)}{2},$$

(vide *Tab. Reg.*, p. xxxix.), which implies for *α Virginis* an annual proper motion of $-0^s.00285$. But if we now assume the value for 1755, obtained by the direct comparison with the sun, we shall find, by the comparison with the right-ascension for 1825, a proper motion of but $-0^s.00094$. With these two proper motions and the above difference of $-0^s.135$, we have the correction for the *Tabulæ Regiomontanæ* $= -0^s.135 - (-0^s.00285 + 0^s.00094)\ t = -0^s.135 + 0^s.00191\ t$, in which t denotes the number of years elapsed since 1755. The correction for the above values found by means of the comparisons is, therefore, $= +0^s.135 - 0^s.00191\ t$. From this we have: —

Year.	Correction.	Corrected Values.	Year.	Correction.	Corrected Values.
	s.	s.		s	s
1766	+0.114	−0.009	1787	+0.074	−0.021
1770	0.106	−0.050	1789	0.070	−0.057
1773	0.101	−0.010	1791	0.066	−0.016
1775	0.097	−0.053	1795	0.059	−0.106
1777.5	0.093	−0.005	1797	0.055	−0.036
1778.5	0.091	−0.029	1800	0.049	−0.073
1780	0.087	+0.021	1802	0.045	−0.085
1782.5	0.083	+0.057	. .	. .	. .
1783.5	0.081	+0.027	. .	. .	. .
1785	+0.078	+0.053	1812.5	+0.026	−0.071

A minimum took place about the year 1783, and a maximum most probably about 1805, according to the values before and after it, which gives us the half of the probable period = 22 years, and the whole period = about 44 years. In accordance with this, there have been a minimum about 1827, and maxima about 1761 and 1849. Let us now see whether the modern observations confirm this or not.

In order to obtain decimals as far as three places, I have calculated anew the means of the Greenwich observations from 1835 to 1847 for *α Virginis*, as well as for *β Orionis*, *α Orionis*, and *α Canis minoris*. I have taken the liberty to exclude some observations which differ too much from the mean, and from all the other individual observations.

Year.	*α Virginis.* Observation.	*α Virginis.* Correction *Tab. Reg.*	*β Orionis* minus Tables.	*α Orionis* minus Tables.	*α Canis minoris* minus Tables.	Mean.	Observation minus Corr. *Tab. Reg.* = *D*.	*D* minus Mean.
	s.	s.	s.	s.	s.	s.	s.	s.
1835	30.599	30.601	+0.030	+0.105	+0.022	+0.052	—0.002	—0.054
1836	33.731	33.751	+0.060	+0.072	—0.014	+0.039	—0.020	—0.059
1837	36.900	36.900	+0.088	+0.089	+0.020	+0.066	0.000	—0.066
1838	39.999	40.049	+0.058	+0.073	—0.016	+0.038	—0.050	—0.088
1839	43.177	43.198	+0.088	+0.045	+0.006	+0.046	—0.021	—0.067
1840	46.338	46.348	+0.109	+0.109	—0.019	+0.066	—0.010	—0.076
1841	49.493	49.498	+0.087	—0.006	—0.032	+0.016	—0.005	—0.021
1842	52.597	52.646	+0.098	+0.063	+0.021	+0.061	—0.049	—0.110
1843	55.687	55.796	+0.056	—0.066	—0.055	—0.022	—0.109	—0.087
1844	58.837	58.946	—0.029	—0.006	—0.025	—0.020	—0.109	—0.089
1845	2.021	2.096	—0.038	—0.045	—0.021	—0.035	—0.075	—0.040
1846	5.107	5.246	+0.038	+0.014	—0.039	+0.004	—0.139	—0.143
1847	8.272	8.397	+0.014	—0.057	—0.035	—0.026	—0.125	—0.099

This table shows evidently that the maximum may have taken place about 1849, as the period above ascertained made probable.

I shall take the liberty of saying something more concerning what has been brought forth against Bessel's result, (with respect to *Sirius*,) by a weighty authority, which perhaps would have deterred me from proceeding farther, had I not been already too strongly convinced of the truth of the supposition. Mr. Struve, in his "*Études d'Astronomie Stellaire*," *note finale*, subjects Bessel's results to a new mode of treatment, and endeavors to distribute the differences according to the method of the least squares. The remaining differences, however, exhibit such a regular progression, that he says it is very difficult not to subscribe to Bessel's opinion. He intrusted Mr. Fuss with the task of bringing the matter to decision by means of comparisons of *Sirius* with stars in its vicinity. These stars are determined by Bradley and Piazzi for 1755 and 1800. Observations were made at Greenwich and Dorpat for 1829, and at Pulkowa for 1847. Mr. Fuss had thus four equations of condition, and the remaining differences after the solution of the equations show no irregularity in the proper motion of *Sirius* in relation to the seven stars of comparison which were adopted. Mr. Struve says then, " But how are the irregularities indicated in Bessel's results to be explained? It may be that some instruments have imperfections in the construction of the pivots, which, if the difference in declination is great, will affect the differences in right-ascension; moreover, the so-called personal equations may exist for some astronomers." I am disposed to believe, however, that this latter objection may itself be brought against the equations of Mr. Fuss. It is very probable, also, that similar irregularities occur in the stars used for comparison, by which, under some circumstances, Bessel's result might have been canceled.

I reasoned now in this way: If the results obtained by Bessel are correct, there must have occurred (since they indicate a period of about fifty years, and a maximum took place in 1794) a new maximum about 1844, and of nearly the same value. I therefore calculated the means of the mean right-ascensions of *Sirius*, observed at Greenwich from 1835 to 1847, compared them with the *Tabulæ Regiomontanæ*, and found the following surprising result: —

Year.	Observation.	Tables.	Observation minus Tables.	Relation to the Comparison-Stars.
	s.	s.	s.	s.
1835	52.605	52.489	+0.116	+0.064
1836	55.341	55.133	0.208	0.169
1837	58.033	57.777	0.256	0.190
1838	0.658	0.421	0.237	0.199
1839	3.359	3.065	0.294	0.248
1840	6.014	5.709	0.305	0.239
1841	8.655	8.353	0.303	0.287
1842	11.328	10.998	0.330	0.269
1843	13.928	13.642	0.286	0.308
1844	16.513	16.286	0.227	0.247
1845	19.136	18.930	0.206	0.241
1846	21.770	21.574	0.196	0.192
1847	24.368	24.218	+0.150	+0.172

According to this table, the maximum is again nearly of the same value as that obtained by Bessel for 1794, and his supposition of a period of about fifty years confirmed.

Bessel has suspected that the stars which exhibit such irregularities move round dark bodies. Since the conviction has been forced upon me, during my labors, that such changes are

common to all the fixed stars, although in most cases insignificant or included in long periods, I must venture to differ from BESSEL's opinion, at least in some measure. There may exist peculiarities in the motion of the fixed stars in space which produce such variations in the proper motion, but which, together with their causes, we are not yet able to explain. A fixed star, round which large and very distant planets are moving, admitting almost of being considered as revolving fixed stars, but invisible to us, will not itself move in the curve of the proper motion, but this curve will rather be described by the common center of gravity. Might not the variations in the proper motion be explained by this supposition, and might not this explanation also extend to the peculiar changes in the signs (perturbations) indicated in the above table? — Upon this subject the future must decide.

If the event should prove that the question of the variation in the proper motion of the fixed stars has been decided by my investigations, it must be confessed that it has been made possible at this early period only by the great service which the English astronomers have rendered to the science in their numerous observations, continued without interruption during the last hundred years.

I trust that my labors will have the effect of directing the earnest attention of astronomers towards this highly important subject.

Cambridge, 1850, *September* 9.

FROM A LETTER OF PROFESSOR SCHUMACHER TO THE EDITOR.

Altona, 1850, *August* 27.

LUTHER obtained on the 24th the following new elements of *Parthenope*, from the observations at Naples, May 11, 12, 13, 14, 15, Berlin, June 24, and Berlin, August 4, 5, 6.

Epoch 1850, May 25.0, M. T. Berlin.

M	$288^\circ\,40'\,43''.27$	
π	316 49 51.82	M. Equinox, 1850, Jan. 0.
☊	124 57 55.78	M. Equinox, 1850, Jan. 0.
i	4 36 56.75	
φ	5 42 30.35 ($e = 0.09946616$)	
Log. a	0.3893138	
μ	$924''.7747$	

Sidereal period 1401 days.

From D'ARREST, I have just received his V. Elements of *Astræa*.

ASTRÆA.

Epoch 1846, January 0.0, M. T. Berlin.

Mean Longitude,	$94^\circ\,6'\,1''.12$
Mean Anomaly,	318 45 2.68
Perihelion,	135 20 58.44
Node,	141 25 13.59
Inclination,	5 19 23.19
Angle of Eccentricity,	10 50 28.34
Mean Daily Sid. Motion,	$857''.60899$
Log. Mean Distance,	0.4111449
Period,	1511.178 days.

The normal places are represented as follows: —

	$\Delta\alpha \cos\delta$	$\Delta\delta$	
1845, Dec. 21	$+1''.92$	$-0''.57$	Value = 1.
1846, Jan. 10	−0.12	−0.81	
30	+0.27	−1.04	
Feb. 19	+0.24	−1.34	
Mar. 11	−0.68	−0 53	
31	−0.98	+0.41	
April 20	−1.48	+1.99	
1847, Jan. 12,	−0.13	−0.62	Value = 0.447.
March 13,	+3.57	−0.17	
April 22,	−1.30	+1.41	
May 14,	+0.77	−2.52	
June 3,	−0.33	−0.71	
23,	+0.43	−0.78	
1848, Aug. 12,	−0.74	−1.25	Value = 1.
1849, Nov. 10,	+0.34	+0.88	

H. C. SCHUMACHER.

FROM A LETTER OF PROFESSOR CHALLIS TO THE EDITOR.

Cambridge Observatory, *England*, 1850, *Aug.* 27.

I am now observing *Parthenope* as often as the very cloudy summer, that we have here, will permit, and append the latest for insertion in the Astronomical Journal. Daylight and the mists of the horizon render the planet so faint an object, that I can scarcely hope to get additional observations. In America it will probably be observed some time longer.

Parthenope.

Greenwich M. T.			App. R.A.	Log. $\frac{p}{P}$	App. N.P.D.	Log. $\frac{q}{P}$	No. Comp.	Star.
		h. m. s.	h. m. s.		° ′ ″			
1850, July	15	10 20 36.8	14 54 57.03	8.470	101 22 30.9	—9.9330	7	*a*
Aug.	9	9 21 0.9	15 13 8.39	8.510	103 48 22.4	—9.9334	11	*b*
	12	9 40 58.9	15 16 13.84	8.550	104 8 5.1	—9.9263	5	*c*
	23	9 1 14.1	15 28 56.47	8.541	105 21 54.3	—9.9305	2	*d*
	24	8 38 16.3	15 30 10.41	8.512	105 28 37.1	—9.9363	5	*e*
	24	9 1 1.6	15 30 12.06	8.545	105 28 40.5	—9.9299	1	*f*
	26	8 36 48.4	15 32 44.29	8.518	105 42 11.2	—9.9356	8	*e*

The observations are corrected for refraction. p is the correction (in time) to be added to the App. R.A., and q the correction to be added to the App. N.P.D. for parallax. P is the equatorial horizontal parallax of the planet at the time of observation. The places of the stars are taken from the catalogues named below.

a, Bessel (Weisse), XIV. 1012
b, Bessel (Weisse), XV. 199
c, " " XV. 265
d, " " XV. 644
e, Brit. Assoc. Catal. 5184
f, " " " 5190

The observations were taken with the Northumberland telescope.

J. CHALLIS.

SECOND COMET OF 1850.

Additional elements of this comet have been computed by Messrs. Runkle and Safford.

By Mr. J. D. Runkle.

Longitude of Node,	206° 3′ 25″.4
Longitude of Perihelion,	89 14 45.8
Inclination,	40 1 7.5
Log. Perihelion Distance,	9.752455
Perihelion Passage,	Oct. 19.34118

By Mr. T. H. Safford, Jr.

From Cambridge observations, August 29, September 3, and September 8.

T	1850, Oct. 19.3433 Greenwich M. T.
Log. q	9.751524
π	89° 20′ 17″
☊	205 55 47
i	40 10 52

The comparison with the middle observation gives, —

C. — O.

$$\Delta\lambda \cos\beta = +1''.3$$
$$\Delta\beta = +5''.2$$

Messrs. Runkle and Safford have computed the following ephemeris from Safford's elements: —

8h, M. T. Washington.		α	δ	Log. Δ
		h. m.	° ′	
1850, Sept.	14	7 16.1	+44 49	9.61900
	16	7 42.5	40 06	9.60843
	18	8 6.4	34 49	9.60365
	20	8 27.9	29 12	9.60165
	22	8 47.1	23 29	9.60621
	24	9 4.2	17 54	9.62690
	26	9 19.6	12 36	9.63307
	28	9 33.6	7 32	9.66578
	30	9 46.4	+ 3 15	9.67912
Oct.	2	9 58.2	— 0 42	9.70644
	4	10 9.2	4 12	9.73263
	6	10 19.7	7 13	9.76347
	8	10 29.8	9 52	9.79330
	10	10 39.4	12 10	9.82173
	12	10 48.9	—14 8	9.85020

The comet passes nearest the earth September 19, at a distance of about 0.4005.

G.

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The appearance of this No. has unfortunately been delayed by difficulties in the printing department.

THE

ASTRONOMICAL JOURNAL.

No. 17.

VOL. I. CAMBRIDGE, OCTOBER 15, 1850. NO. 17.

NOTE FROM LIEUTENANT DAVIS TO THE EDITOR.

Cambridge, September 19, 1850.

I HAVE the pleasure to transmit to you for publication, Mr. SEARS C. WALKER's new method of presenting the formulas for the computation of the coefficients of the perturbative function, to which he has been led in the course of the numerical computation of these coefficients, undertaken at my request.

CHARLES HENRY DAVIS,
Lieut., Superintendent Nautical Almanac.

ON THE COMPUTATION OF COEFFICIENTS IN THE DEVELOPMENT OF THE PERTURBATIVE FUNCTION.

BY SEARS C. WALKER.

THE fundamental formula of LAPLACE for the coefficient $b_s^{(i)}$ in the development of the radical $(1+\alpha^2-2\alpha\cos\varphi)^{-s}$, in Volume III. page 70 of the *Mécanique Céleste*, may be thus transformed: —

$$\text{I.} \qquad b_s^{(i)} = \Sigma_{n=0}^{n=+\infty} \; \frac{\Gamma(s, s+n-1)}{\Gamma(1, n)} \cdot \frac{\Gamma(s, s+i+n-1)}{\Gamma(1, i+n)} \cdot \alpha^{i+2n}$$

Γ being used as a symbol to denote the product of all the factors varying always by unity between the two limits in the parenthesis, or by making

$$\text{II.} \qquad {}_{n}\mathrm{N}_{s}^{(i)} = \frac{\Gamma(s, s+n-1)}{\Gamma(1, n)} \cdot \frac{\Gamma(s, s+i+n-1)}{\Gamma(1, i+n)}$$

$$\text{III.} \qquad b_s^{(i)} = \Sigma_{n=0}^{n=+\infty} \; {}_{n}\mathrm{N}_{s}^{(i)} \cdot \alpha^{i+2n}$$

Here the indices s, n, and i are conformable to the notation of LAPLACE. $2s$ takes all values of odd numbers, and n and i all values of whole numbers, 0 included. By applying to N a fourth index to denote the order of differentiation of $b_s^{(i)}$, with reference to α, or to the ratio $\frac{a}{a'}$ of the mean distances of a disturbed and disturbing planet, we have,

$$\alpha^m D_\alpha^m \, b_s^{(i)} = \Sigma_{n=0}^{n=+\infty} \; {}^{m}_{n}\mathrm{N}_{s}^{(i)} \cdot \alpha^{i+2m} \qquad \text{IV.}$$

in which the zero term for all the indices is, ${}^{0}_{0}\mathrm{N}_{0}^{0} = 2$, and

$$\text{V.} \qquad {}^{m}_{n}\mathrm{N}_{s}^{(i)} = \frac{\Gamma(s, s+n-1)}{\Gamma(1, n)} \cdot \frac{\Gamma(s, s+i+n-1)}{\Gamma(1, i+n)} \cdot \Gamma(i+2n, i+2n-[m-1]) \cdot {}^{0}_{0}\mathrm{N}_{0}^{0}$$

And in like manner for any higher accented indices,

$$\text{VI.} \qquad {}^{m'}_{n'}\mathrm{N}_{s'}^{(i')} = \frac{\Gamma(s+n, s'+n'-1)}{\Gamma(s, s'-1) \cdot \Gamma(n+1, n')} \cdot \frac{\Gamma(s+i+n, s'+i'+n'-1)}{\Gamma(s, s'-1) \cdot \Gamma(i+n+1, i'+n')} \cdot \frac{\Gamma(i'+2n', i'+2n'-[m'-1])}{\Gamma(i+2n, i+2n-[m-1])} \cdot {}^{m}_{n}\mathrm{N}_{s}^{(i)}$$

or for an increase of 1 in any index,

$$(a) \qquad {}^{m+1}_{n}\mathrm{N}_{s}^{(i)} = (i+2n-m) \cdot {}^{m}_{n}\mathrm{N}_{s}^{(i)}$$

$$(b) \qquad {}^{m}_{n}\mathrm{N}_{s}^{(i+1)} = \frac{(s+i+n) \cdot (i+2n+1)}{(i+n+1) \cdot (i+2n+1-m)} \cdot {}^{m}_{n}\mathrm{N}_{s}^{(i)}$$

$$(c) \qquad {}^{m}_{n+1}\mathrm{N}^{(i)}_{s} = \frac{(s+n)\,.\,(s+i+n)\,.\,(i+2\,[n+1])\,.\,(i+2\,[n+1]-1)}{(n+1)\,.\,(i+n+1)\,.\,(i+2\,n-[m-1]+1)\,.\,(i+2\,n-[m-1])}\,.\,{}^{m}_{n}\mathrm{N}^{(i)}_{s}$$

$$(d) \qquad {}^{m}_{n}\mathrm{N}^{(i)}_{s+1} = \frac{(s+n)\,.\,(s+i+n)}{s^2}\,.\,{}^{m}_{n}\mathrm{N}^{(i)}_{s}$$

and for the same, in the case of $m = 0$,

$$(a') \qquad {}^{1}_{n}\mathrm{N}^{(i)}_{s} = (i+2\,n)\,.\,{}^{0}_{n}\mathrm{N}^{(i)}_{s}$$

$$(b') \qquad {}^{0}_{n}\mathrm{N}^{(i+1)}_{s} = \frac{s+i+n}{i+n+1}\,.\,{}^{0}_{n}\mathrm{N}^{(i)}_{s} \qquad = \frac{s+n}{n+1}\,.\,{}^{0}_{n+1}\mathrm{N}^{(i)}_{s}$$

$$(c') \qquad {}^{0}_{n+1}\mathrm{N}^{(i)}_{s} = \frac{(s+n)\,.\,(s+i+n)}{(n+1)\,.\,(i+n+1)}\,.\,{}^{0}_{n}\mathrm{N}^{i}_{s} \qquad = \frac{s+n}{n+1}\,.\,{}^{0}_{n}\mathrm{N}^{(i+1)}_{s}$$

$$(d') \qquad {}^{0}_{n}\mathrm{N}^{(i)}_{s+1} = \frac{(s+n)\,.\,(s+i+n)}{s^2}\,.\,{}^{0}_{n}\mathrm{N}^{(i)}_{s} = \frac{(n+1)\,.\,(i+n+1)}{s^2}\,.\,{}^{0}_{n+1}\mathrm{N}^{(i)}_{s}$$

These formulas furnish a very plain guide in the computation of N for any of its indices.

If we arrange a scale of $(\mu+2)$ terms of values of N from ${}^{m}_{n}\mathrm{N}^{(i)}_{s}$ to ${}^{m}_{n+1+\mu}\mathrm{N}^{(i)}_{s}$, and differentiate them with reference to n to bring them to the order $(m+1)$, and then take their algebraic differences to the order $(\mu+1)$, making $k = i + 2\,n - m$, we shall have, by the ordinary formula for differences, the upper sign being for odd values of $(\mu+1)$,

$$\Delta^{\mu+1}\;{}^{m+1}_{n}\mathrm{N}^{(i)}_{s} = (k+2\,[\mu+1])\,.\;{}^{m}_{n+1+[\mu]}\mathrm{N}^{(i)}_{s} - \frac{\mu+1}{1}\,.\,(k+2\,\mu)\,.\;{}^{m}_{n+1+[\mu-1]}\mathrm{N}^{(i)}_{s}$$

$$+\frac{\mu+1\,.\,\mu}{1\,.\,2}\,.\,k+2\,[\mu-1])\,.\;{}^{m}_{n+1+[\mu-2]}\mathrm{N}^{(i)}_{s}\;\ldots\;\pm\frac{\mu+1}{1}\,(k+2)\,.\;{}^{m}_{n+1}\mathrm{N}^{(i)}_{s} \mp k\;{}^{m}_{n}\mathrm{N}^{(i)}_{s}$$

Each of these terms may be expressed in functions of ${}^{m}_{n+1}\mathrm{N}^{(i)}_{s}$, and its algebraic differences, by making ω equal successively to μ, $\mu-1$, $\mu-2$, &c., in the common interpolating formula

$${}^{m}_{n+1+\omega}\mathrm{N}^{(i)}_{s} = {}^{m}_{n+1}\mathrm{N}^{(i)}_{s} + \frac{\omega}{1}\,.\,\Delta\;{}^{m}_{n+1}\mathrm{N}^{(i)}_{s} + \frac{\omega\,.\,\omega-1}{1\,.\,2}\,.\,\Delta^2\;{}^{m}_{n+1}\mathrm{N}^{(i)}_{s} + \&c.$$

And we shall have,

$$\Delta^{\mu+1}\;{}^{m+1}_{n}\mathrm{N}^{(i)}_{s} = (k+2\,[\mu+1])\,.\,\Delta^{\mu}\;{}^{m}_{n+1}\mathrm{N}^{(i)}_{s} - k\,.\,\Delta^{\mu}\;{}^{m}_{n}\mathrm{N}^{(i)}_{s}$$

$$+\left[\begin{array}{lll} + & (\frac{\mu}{1}) & (k+2\,[\mu+1]) \\ - & (\frac{\mu+1}{1}) & (k+2\,[\mu\quad]) \\ + & & (k+2\,[\mu-\mu]) \end{array}\right]\Delta^{\mu-1}\;{}^{m}_{n+1}\mathrm{N}^{(i)}_{s}$$

$$+\left[\begin{array}{lll} + & (\frac{\mu\,.\,\mu-1}{1\,.\,2}) & (k+2\,[\mu+1]) \\ - & (\frac{\mu+1}{1})\;(\frac{\mu-1}{1}) & (k+2\,[\mu\quad]) \\ + & (\frac{\mu+1\,.\,\mu}{1\,.\,2}) & (k+2\,[\mu-1]) \\ - & & (k+2\,[\mu-\mu]) \end{array}\right]\Delta^{\mu-2}\;{}^{m}_{n+1}\mathrm{N}^{(i)}_{s}$$

$$+\left[\begin{array}{lll} + & (\frac{\mu\,.\,\mu-1\,.\,\mu-2}{1\,.\,2\,.\,3}) & (k+2\,[\mu+1]) \\ - & (\frac{\mu+1}{1})\;(\frac{\mu-1\,.\,\mu-2}{1\,.\,2}) & (k+2\,[\mu\quad]) \\ + & (\frac{\mu+1\,.\,\mu}{1\,.\,2})\;(\frac{\mu-2}{1}) & (k+2\,[\mu-1]) \\ - & (\frac{\mu+1\,.\,\mu\,.\,\mu-1}{1\,.\,2\,.\,3}) & (k+2\,[\mu-2]) \\ + & & (k+2\,[\mu-\mu]) \end{array}\right]\Delta^{\mu-3}\;{}^{m}_{n+1}\mathrm{N}^{(i)}_{s} \qquad + \&c.$$

$$
\begin{aligned}
+\Big[+ & \qquad\quad \left(\tfrac{\mu\,.\,\mu-1\,.\,.\,.\,.\,1}{1\,.\,2\,.\,3\,.\,.\,.\,.\,\mu}\right)\,(k+2\,[\mu+1]) \\
- & \left(\tfrac{\mu+1}{1}\right)\left(\tfrac{\mu-1\,.\,\mu-2\,.\,.\,.\,.\,1}{1\,.\,2\,.\,3\,.\,.\,.\,.\,\mu-1}\right)\,(k+2\,[\mu \qquad]) \\
+ & \left(\tfrac{\mu+1\,.\,\mu}{1\,.\,2}\right)\left(\tfrac{\mu-2\,.\,\mu-3\,.\,.\,.\,.\,1}{1\,.\,2\,.\,3\,.\,.\,.\,.\,\mu-2}\right)\,(k+1\,[\mu-1]) \\
& \quad .\qquad .\qquad .\qquad .\qquad . \\
\pm & \,(\mu+1\,.\,\mu\,.\,.\,.\,.\,2)\,(k+2\,[\mu-(\mu-2)]) \\
\mp & \qquad\qquad\qquad (k+2\,[\mu-\mu]) \qquad \Big]\,{}^{m}_{n+1}\mathrm{N}^{(i)}_{s}
\end{aligned}
$$

It will be readily seen, that in this formula, whatever be the value of k or μ, the series within each pair of brackets is a periodical function, the sum of its terms being 0. Hence the general theorem,

$$\Delta^{\mu+1}\;{}^{m+1}_{n}\mathrm{N}^{(i)}_{s} = [k+2\,(\mu+1)]\,.\,\Delta^{\mu}\;{}^{m}_{n+1}\mathrm{N}^{(i)}_{s} - k\,.\,\Delta^{\mu}\;{}^{m}_{n}\mathrm{N}^{(i)}_{s}$$

from which it appears that, while the differencing to obtain $\Delta^{\mu+1}$ relates to the first and second terms of Δ^{μ}, the differentiation to obtain $(m+1)$ relates to the first and last of the scale of primitive terms, whose last order of differences is $(\mu+1)$, the other differential factors being necessary to complete the periodical character of the series within the brackets. The general principle here demonstrated was inferred by LE VERRIER* from particular cases; but it could not be enunciated in its most simple and general form by his nomenclature, the index m being a necessary auxiliary.

The practical applications of this theorem admit of equally interesting and general expressions. If we make $\beta^2 = \frac{\alpha^2}{1-\alpha^2}$, we may have the following transformation of formula IV.: —

$$\alpha^{m}\,D^{m}_{\alpha}\,b^{(i)}_{s} = \Sigma^{\nu=\mu-1}_{\nu=0}\;\beta^{2(\nu-1)}\,.\,\Delta^{\mu}\;{}^{m}_{0}\mathrm{N}^{(i)}_{s}\,.\,\alpha^{k} + \Sigma^{n=+\infty}_{n=0}\;\beta^{2\mu}\,.\,\Delta^{\mu}\;{}^{m}_{n}\mathrm{N}^{(i)}_{s}\,.\,\alpha^{k}.$$

This is the general expression of all the particular series given by LE VERRIER.† Among the endless variety of relations between μ, m, and s, in this theorem, those selected by LE VERRIER, in consequence of their rapid convergency, may be comprised in the expressions, $\mu = \frac{1}{2}+s$, $m = \frac{3}{2}-s$.

Whence,

$$\alpha^{m}\,D^{m}_{\alpha}\,b^{(i)}_{s} = \Sigma^{\nu=s-\frac{1}{2}}_{\nu=0}\;\beta^{2(\nu-1)}\,.\,\Delta^{\nu}\;{}^{m}_{n}\mathrm{N}^{(i)}_{s}\,.\,\alpha^{k} + \Sigma^{n=+\infty}_{n=0}\;\beta^{2s+1}\,.\,\Delta^{s+\frac{1}{2}}\;{}^{m}_{n}\mathrm{N}^{(i)}_{s}\,.\,\alpha^{k}.$$

This form makes the primitive series for $b^{(i)}_{\frac{1}{2}}$ depend on $\Delta\;{}^{1}_{n}\mathrm{N}^{(i)}_{s}$; $b^{(i)}_{\frac{3}{2}}$ on $\Delta^{2}\;{}^{0}_{n}\mathrm{N}^{(i)}_{\frac{3}{2}}$; $b^{(i)}_{\frac{5}{2}}$ on $\Delta^{3}\;{}^{m}_{n}\mathrm{N}^{(i)}_{\frac{5}{2}}$; &c., &c.

In Professor PEIRCE's development of the perturbative function (*Astr. Journ.*, No. 1), the form of the differentials of $b^{(i)}_{\frac{3}{2}}$, $b^{(i)}_{\frac{5}{2}}$, &c., is thus modified: —

$$\alpha^{m}\,D^{m}_{\alpha}\,(\alpha\,b^{(i)}_{\frac{3}{2}})\,,\quad \alpha^{m}\,D^{m}_{\alpha}\,(\alpha^{2}\,b^{(i)}_{\frac{5}{2}})\,,\;.\,.\,.\,.\,.\;\alpha^{m}\,D^{m}_{\alpha}\,(\alpha^{s-\frac{1}{2}}\,b^{(i)}_{s}).$$

In this case, the factor k, instead of $(i+2\,n-m)$, becomes $(i+2\,n+s-\frac{1}{2}-m)$.

The negative values of m belong to series of integrals which, being successively differentiated for α to the order $(m=0)$, give the primitive series for $b^{(i)}_{s}$.

* Additions to the *Connaissance des Temps*, 1848, p. 22.

† *Ibid.*, pp. 18–22.

SECOND COMET OF 1850.

PROFESSOR SCHUMACHER issued circulars, September 10 and 13, announcing the discovery of this comet on the 5th, by Mr. BRORSEN at Senftenberg.

BRORSEN's comparisons with a star in ARGELANDER's Zones (Z. 84, No. 85),

$$\alpha = 74^{\circ}\;23'\;50''.0 \qquad \delta = +56^{\circ}\;39'\;23''.1$$

gave for the comet's place,

Senftenberg M. T.	☌ α	☌ δ	Comp.
	h. m. s.	° ′ ″	° ′ ″	
Sept. 5 11 49 26	74 4 46.1	+57 3 2.1	4

At Altona, Dr. PETERSEN observed it by comparison with two of ARGELANDER's stars.

Altona M. T.	☄ α	☄ δ	Comp.
Sept. 9 9h 19m 39s.0	89° 28′ 58″.0	+53° 42′ 51″.2	5
12 11 38 17.6	101 29 1.0	+49 2 30.3	6

The apparent positions of the comparison-stars on the 9th were,

	✱ α	✱ δ
b	5h 58m 53s.70	+53° 38′ 1″.6
c	5 59 41.23	+53 51 1.4

The comet was compared in declination only with *b*; — in right-ascension with both, three times with *c*.

The comparison-star on the 10th was,

$\alpha = 6^{h.}\ 43^{m.}\ 21^{s.}.16 \qquad \delta = +49°\ 4'\ 45''.7.$

Mr. GRAHAM, in Markree, compared it, September 9, with the star (*b*), ARGEL. Zone 163, No. 169, whose place he determined as follows: —

$\alpha = 5^{h.}\ 58^{m.}\ 53^{s.}.67 \qquad \delta = +53°\ 38'\ 1''.8$

He obtained,

Greenwich M. T.	☄ α	☄ δ	Comp.
Sept. 9 13h 4m 33s	6h 0m 51s.5	+53° 29′ 22″	5
14 5 25	6 1 31.5	+53 26 17	5

but remarks that the reductions are not perfectly accurate, — yet that the change in consequence of more precise reduction would be but slight.

Mr. RÜMKER's observations at Hamburg are,

Hamburg M. T.	☄ α	☄ δ
Sept. 10 8h 38m 12s.5	93° 19′ 14″.6	+52° 27′ 4″.5
12 9 47 14.8	101 11 43.0	+49 10 50.4

No better elements or nearer ephemeris than those in No. 16 of the *Astr. Journ.* can be given, until later observations are received. None of the numerous American telescopes have furnished any observation of the comet in September, later than the European ones already received. For the final determination of the orbit, astronomers will be almost entirely dependent on European observations.

G.

OBSERVATIONS OF THE FIRST COMET OF 1850, AND PARTHENOPE.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant MAURY, Director of the Observatory.

[Corrected for refraction.]

FIRST COMET OF 1850.

Date.	M. T. Washington.	No. Comp.	Comparison-Star.	☄ — ✱ Δα	☄ — ✱ Δδ	☄'s apparent α	☄'s apparent δ	A.*
1850.	h. m. s.			m. s.	′ ″			
June 29	12 17 34.76	10	*u*	+0 21.33	+12 7.36			8
30	12 2 24.14	7	*v*	+1 1.54	+ 0 56.16			9
		7	*w*	—1 0.40	+ 8 51.32			9
July 1	11 21 10.12	10	*y*	+1 9.19	+ 1 13.33			10
3	10 0 27.54	3	*x*	—1 6.59	— 5 46.60			10
4	10 23 19.48	9	*z*	—0 36.96	+ 2 27.83			10
7	9 36 18.72	8	*a′*	—0 12.59	—12 35.98	h. m. s.	° ′ ″	7
10	10 50 47.22	6	Rümker, 4529	+2 22.24	— 0 6.09	13 52 56.84	+25 44 8.07	9
11	11 9 56.54	6	Rümker, 4545	—3 32.77	+10 11.50	13 50 0.11	+22 56 41.38	9
14	9 48 10.76	5	Weisse XIII. 737	+1 9.45	+ 7 6.22	13 43 57.14	+14 21 9.66	9
	10 16 17.66	7	"	+1 7.14	+ 3 43.52	13 43 54.83	+14 17 46.93	9
20	9 13 3.62	8	Weisse XIII. 512	+2 37.68	—15 20.79	13 32 40.65	— 2 43 31.21	7

* The numbers in the column A indicate the condition of the atmosphere, 10 expressing the most favorable condition.

Adopted Mean Places for 1850.0 *of Comparison-Stars.*

*	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
u	9	14 26 9	+50 51 5	Approximate places.
v	9	14 21 3	+49 10 3	
w	9	14 23 3	+49 2 4	
y	8.9	14 18 5	+47 41 6	
x	8.9	14 14 0	+43 40 1	
z	8.9	14 10 3	+41 14 6	
a′	9	14 1	+34 15 6	
Rümker, 4529	6	13 50 33.70	+25 44 5 17	Rümker's Catalogue.
Rümker, 4545	8	13 53 31.95	+22 46 21.60	"
Weisse XIII. 737	8.9	13 42 46.74	+14 13 58.01	Weisse's Catalogue.
Weisse XIII. 512	7	13 30 2.01	— 2 28 9.96	"

PARTHENOPE.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	Parthenope — Star Δα	Parthenope — Star Δδ	Parthenope's apparent α	Parthenope's apparent δ	A.
1850.	h. m. s.			m. s.	′ ″	h m s	° ′ ″	
Aug. 11	8 23 1.37	4	Weisse XV. 265	+0 10.22	—14 2.38	15 15 21.62	—14 2 35.81	9
	9 20 33.79	10	" 265	+0 12.44	—14 18.46	15 15 23.94	—14 2 51.88	9
		10	" 281	—0 22.46	—16 34.31	15 15 24.63	—14 2 53.32	9
12	8 20 47.34	8	" 249	+2 7.17	+10 59.74	15 16 25.18	—14 9 15.23	9
(1) 14	8 45 52.48	5	" 400	—3 1.30	— 5 4.74	15 18 35.58	—14 22 43.74	7
15	8 8 0.69	4	" 400	—1 56.48	—11 29.15	15 19 40.37	—14 29 8.10	9
	8 35 51.26	6	" 400	—1 54.95	—11 35.96	15 19 41.95	—14 29 14.90	9
16	8 22 14.32	12	" 400	—0 47.86	—18 19.19	15 20 49.08	—14 36 0 79	10
23	8 39 11.01	3	Madras, 1947; B. A. C. 5184	—5 10.13	+ 8 26.74	15 29 11.60	—15 23 15.90	6
25	8 2 58.28	9	"	—2 39.91	— 5 2.35	15 31 41.71	—15 36 43.88	7
26	8 14 53.74	5	"	—1 21.62	—11 48.00	15 32 59.97	—15 43 27.37	10
27	7 54 31.53	9	*g*	+0 41.88	—11 57.83	15 34 17.34	—15 50 13.02	8
28	7 50 9.41	9	"	+2 1.13	—18 43.18	15 35 36.80	—15 56 58.48	9
29	7 45 23.57	13	*h*	+0 54.45	— 8 25.14	15 36 56.97	—16 3 43.10	9
(2) 30	7 49 35.32	3	"	+2 15.23	—15 9.76	15 38 18.13	—16 10 31.47	4
	8 12 21.44	3	"	+2 17.94	—15 10.89	15 38 20.44	—16 10 32 60	4
(3) 31	7 48 39.14	8	Lal. 28697	+2 19.38	+11 18.50	15 39 41.41	—16 17 13.68	6
Sept. 2	8 36 37.90	4	B. A. C. 5257	—2 46.90	—13 44.69	15 42 31.50	—16 30 48.30	7
3	7 51 24.83	12	"	—1 24.62	—20 20.12	15 43 53.87	—16 37 23.69	9
6	8 18 48.57	6	*k*	+1 19.70	— 9 4.45	15 47 36.15	—16 57 32 62	8
10	7 39 52.61	4	Lal. 29306	—4 26.25	+ 7 45.10	15 54 13.12	—17 23 42.55	8
(4) 11	7 23 28.11	8	"	—2 55.38	+ 1 16.68	15 55 44.00	—17 30 10.92	10
12	7 41 44.11	7	"	—1 21.27	— 5 14.53	15 57 18.09	—17 36 40.74	10
13	7 39 45.15	10	"	+0 11.95	—11 28.66	15 58 51.30	—17 42 56.36	10

(1) Moon close to planet, which is not well seen. (2) Very misty. (3) Misty. (4) Moon close to planet.

Adopted Mean Places for 1850.0 *of Comparison-Stars.*

*	Mag.	α	Ann. Prec.	δ	Ann. Prec.	Authority.	No. Comp
		h. m. s	s.	° ′ ″	″		
Weisse XV. 265	8	15 15 10.01	+3.317	—13 48 34.38	—13.212	Weisse's Catalogue.	
" 281	8	15 15 45.67	3.318	—13 46 19.99	13.184	"	
" 249	9	15 14 16.63	3.327	—14 20 15.82	13.284	"	
" 400	8	15 21 35.52	3.333	—14 17 40.26	12.795	"	
B. A. C. 5184; Madras, 1947	7	15 34 20.39	3.369	—15 31 43.33	11.917	Madras Observations.	
g	9.10	15 33 34.46	3.374	—15 38 17.20	11.966	W. Equatorial diff. from B. A. C. 5184.	10
h	9	15 36 1.26	3.379	—15 55 19.82	11.789	W. Equatorial diff. from *g*.	10
Lal. 28697	7	15 37 20.79	3.392	—16 28 33 98	11.693	Lalande's Catalogue.	
B. A. C. 5257; Rümker, 5204	4.5	15 45 17.42	3.396	—16 17 5.88	11.137	Rümker's Catalogue.	
k	9.10	15 46 55.17	3.408	—16 48 30.46	11.021	W. Equatorial diff. from B. A. C. 5257.	5
Lal. 29306	8	15 58 38.19	+3.435	—17 31 30.26	—10.131	Lalande's Catalogue.	

NEW PLANET.

A CIRCULAR of Professor SCHUMACHER's, dated September 20, announces the discovery of a planet, on the 13th September, by Mr. HIND, at Mr. BISHOP's Observatory in London.

Mr. HIND observed as follows: —

	Greenwich M. T.	α	δ
	h. m. s.	h. m. s.	° ′ ″
Sept. 13	11 29 36	23 44 45.08	+14 6 42.9
14	8 28 24	23 44 2.56	+13 59 29.3

The Editor is indebted to Mr. BOND for later observations made by Mr. HARTNUP, of the observatory in Liverpool.

	Greenwich M. T.	α	N P D.
	h. m. s.	h. m. s.	° ′ ″
Sept. 17	11 52 12	23 41 26.03	76 28 36.9
	12 47 1	24.02	57.8

Mr. HIND has selected the name *Victoria*, with "a star surrounded by a laurel-wreath," for a symbol.

Such nomenclature is at variance with established usage, and liable to the objections which have very properly led astronomers to reject the names "*Medicean Stars*," "*Georgium Sidus*," "*Ceres Ferdinandea*," &c., and even those of the astronomers *Herschel* and *Le Verrier*, for the adoption of whose names some arguments might be adduced.

G.

COMET OBSERVATIONS.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL, IN 1845–46.

Communicated by Lieutenant MAURY, Director of the Observatory.

[Corrected for refraction only.]

The observers designated by the initials are Lieutenant MAURY, Mr. WALKER, Professor COFFIN, and Professor HUBBARD.

COMET OF JUNE, 1845.

Date.	M. T. Wash'n.	☄'s apparent α	☄'s apparent δ	Observer.	*'s Mean Place, 1850.0. α	*'s Mean Place, 1850.0. δ	Mag.	Authority.
1845.	h. m. s.	h. m. s.	° ′ ″		h. m. s.	° ′ ″		
June 4	15 10 58.4	4 1 52.18	+41 49 32.47	H.	4 2 16.77	+41 43 30.34	8	Bessel, Z. 510.
12	9 13 32.8	6 38 59.82	43 52 41.74	H.	6 38 32.14	43 55 4.20	8	Washington Observations.
13	8 41 58.7	6 54 34.59	42 56 56.59	H.	6 56 57.73	42 57 55 12	9	"
15	9 1 48.3	7 21 52.98	40 41 55.15	H.	7 21 39.99	40 44 45.93		"
	9 12 40.5	7 21 58.56	40 41 16.48	H.	7 20 43.50	40 39 54.30	7	"
17	8 54 11.5	7 43 8.93	38 16 56.09	C.	7 42 30.14	38 19 7.03	9	"
23	9 8 17.2	8 23 58.17	31 26 10.24	H.	8 24 43.07	31 23 19.28	7	"
24	9 2 10.4	8 28 31.90	30 26 29.04	C.	8 28 58.81	30 32 19.51		"
	9 19 22.1	8 28 34.81	30 25 17.45	C.	8 26 47.95	30 31 51.49	9	"
25	9 14 44.5	8 32 43.79		C.	8 31 44.04	29 24 37.29	9	Bessel, Z. 350.
	9 14 44.5	8 32 43.60		C.	8 31 46.65	29 52 58.83	9	"
	9 14 44.5	8 32 44.03	29 28 0.30	C.	8 32 19.03	29 25 21.98	9	"
July 1	8 52 37.4	8 51 22.20	+24 29 27.31	C.	8 49 59.27	+24 32 33.16	7	Washington Observations.

ENCKE'S COMET, 1845.

Date.	M. T. Wash'n.	☄'s apparent α	☄'s apparent δ	Observer.	*'s Mean Place, 1850.0. α	*'s Mean Place, 1850.0. δ	Mag	Authority.
1845.	h. m. s.	h. m. s.	° ′ ″		h. m. s.	° ′ ″		
July 10	15 29 34.4	5 39 14.67	+29 41 16.55	C.	5 39 19.87	+29 41 31.70	8	Washington Observations.
	15 29 34.4	5 39 14.76	29 41 18.64	C.	5 39 41.97	29 40 14.75	8.9	"
11	15 19 10.0	5 45 49.19	29 39 29.98	H.	5 45 54.29	29 40 8.82	9.10	"
	15 20 18.1	5 45 48.06	+29 39 26.42	H.	5 46 54.90	+29 43 21.58	10	"

BIELA'S COMET, 1846.

Date.	M. T. Wash'n.	☄'s apparent α	☄'s apparent δ	Observer.	*'s Mean Place, 1850.0. α	*'s Mean Place, 1850.0. δ	Mag.	Authority.
1846.	h. m. s.	h. m. s.	° ′ ″		h. m. s.	° ′ ″		
Jan. 12	7 40 40.8	23 52 38.13	—0 26 27.52	M.	23 51 25.08	—0 25 12.20	9.10	Washington Observations.
13	6 27 28.2	23 55 22.65	0 29 38.12	M.	23 54 25.08	0 25 12.20	9.10	"
	6 51 42.4	23 55 25.30		H.	23 54 30.13	0 24	9	"
14	6 53 11.1	23 58 20.79	0 33 10.74	M. & C.	23 59 27.54	0 29 43.43	9.10	"
18	7 29 50.2	0 10 31.96	0 49 33.52	M.	0 14 10.22	0 50 12.68	7.8	"
19	6 37 45.1	0 13 35.92	0 53 31.98	M. & C.	0 14 10.22	0 50 12.68	7.8	"
	6 37 45.1	0 13 36.29	0 53 35.58	M. & C.	0 18 55.84	0 52 50.94	6	Twelve Year Catalogue.
22	7 2 23.4	0 23 24.28	1 7 41.92	M.	0 22 9.90	1 9 5.39	8.9	Washington Observations.
23	7 10 23.8	0 26 44.88	1 12 31.62	M. & C.	0 25 8.31	1 16 22.34	9	"
	7 10 23.8	0 26 45.09	1 12 38.02	M. & C.	0 30 24.50	1 19 44.31	7	"
	7 13 7.2	0 26 45.31	1 12 36.15	M. & C.	0 27 50.80	1 19 48.51	7.8	"
24	7 8 48.2	0 30 8.44	1 17 40.76	M.	0 27 50.80	1 19 48.51	7.8	"
	7 22 20.2	0 30 10.66	1 18 1.18	M.	0 30 24.50	1 19 44.31	7	"
26	6 20 16.6	0 36 54.13	1 28 59.22	M.	0 40 39.65	1 18 27.28	7	"
	6 20 16.6	0 36 54.46	1 28 59.88	M.	0 43 36.26	1 21 11.00	9	"
	6 52 22.4	0 37 2.88	1 29 10.56	M.	0 30 24.50	1 19 44.31	7	"
28	6 43 54.2	0 44 8.63	1 41 31.28	M.	0 38 15.25	1 37 29.90	9	Weisse O. 664, and Wash. Obs.
	6 43 54.2	0 44 8.81	1 41 32.06	M	0 38 53.70	1 39 23.40	9	" O. 674, " "
Feb. 4	7 1 51.6	1 10 52.26	2 34 56.76	W.	1 3 36.01	2 47 7.20	9	Washington Observations.
	7 1 51.6	1 10 52.70		W.	1 5 42.47	2 39 20.14	9	Weisse I. 72.
5	6 49 4.1	1 14 53.33	2 43 49.51	M.	1 14 10.51	2 47 2.57	9	Washington Observations.
9	6 48 13.2	1 31 42.18	3 25 2.67	M.	1 32 1.50	3 16 51.30	9	Weisse I. 564, and Wash. Obs.
	6 50 0.0	1 31 41.78	3 24 56.64	M.	1 33 9.86	3 22 53.31	8	" I. 594, " "
11	8 4 39.5	1 40 45.06	3 48 36.07	M.	1 39 56.05	3 39 35.05	8	" I. 725.
18	7 1 53.4	2 14 2.97	5 23 51.60	M.	2 17 36.21	5 25 42.80	9	Maclear 2.*
21	7 22 46.0	2 29 55.72	6 12 0.15	M.	2 28 4.70	6 19 44.87	9	Weisse II. 475, and Wash. Obs.
	7 31 2.9	2 29 56.80	6 11 58.33	M.	2 26 39.33	6 17 49.14	8	" II. 443, " "
22	7 1 24.4	2 35 18.22	6 28 28.78	M.	2 32 39.02	6 19 37.70	9	" II. 566, " "
March 3	8 46 56.3	3 30 41.53	9 15 56.11	M.	3 25 6.86	9 6 19.16	9	" III. 455, " "
4	8 52 37.9	3 37 44.47	9 35 19.30	M.	3 38 42.94	9 28 48.69	7.8	Maclear 10, " "
	8 57 37.5	3 37 46.05	9 35 28.41	M.	3 38 1.56	9 30 20.15	9	Weisse III. 732, " "
5	8 19 45.5	3 44 34.76	10 3 15.42	M.	3 47 23.51	9 57 56.06	7	" III. 924, " "
8	8 7 11.5	4 6 21.31	10 52 12.01	W.	4 6 21.84	10 46 17.17	7	Maclear 21, " "
10	8 44 35.3	4 21 50.82	11 29 52.82	W.	4 21 49.14	11 23 24.00	7.8	Lalande 8479.
	8 49 11.9	4 21 52.64	11 30 0.22	W.	4 20 43.06	11 27 49.88	7	Maclear 24.
	8 49 11.9	4 21 52.39	11 29 57.14	W.	4 20 54.42	11 30 44.00	8.9	Lalande 8440.
14	8 14 16.6	4 51 27.01	12 38 8.49	M.	4 52 57.60	12 45 43.53	6	Maclear 30, and Wash. Obs.
17	8 48 21.8	5 19 32.09	13 22 1.12	M.	5 18 44.63	13 15 58.55	7.8	" 33, " "
21	8 23 26.7	5 54 10.67	14 5 25.04	M.	5 57 44.49	14 1 39.82	8	Weisse V. 1487, and "
	8 30 17.1	5 54 11.66	14 5 21.60	M.	5 53 25.19	14 11 14.41	8	" V. 1572, " "
	8 30 17.1	5 54 12.45	14 5 26.90	M.	5 57 22.56	14 4 58.58	7	" V. 1479, " "
	8 30 17.1	5 54 12.47	14 5 25.83	M.	5 58 3.12	14 6 50.09	8	" V. 1500, " "
	9 6 24.5	5 54 24.20	14 5 39.67	M.	5 49 34.56	14 11 55.64	4	B. A. C. 1901, " "
30	10 12 10.6	7 11 56.12	14 33 20.13	M.	7 8 17.26	14 21 7.33	7	Weisse VII. 250, " "
	10 12 10.6	7 11 57.00	14 33 9.99	M.	7 9 14.05	14 14 54.88	7	" VII. 283, " "
	10 16 32.1	7 11 57.73	14 33 12.34	M.	7 10 14.91	14 35 3.57	7	" VII. 316, " "
April 3	9 49 2.5	7 43 22.55	14 18 12.98	W.	7 38 35.21	14 19 46.80	7	B. A. C. 2569.
	9 49 2.5	7 43 22.41	14 17 58.99	W.	7 39 2.46	14 12 10.10	5.6	B. A. C. 2573.
15	8 45 11.7	8 1 50.62	12 41 37.59	M.	9 0 5.78	12 42 29.75	7	Weisse VIII. 1529.
19	10 24 43.5	9 23 12.35	—12 5 6.88	W.	9 22 35.61	—12 4 51.30	9	" IX. 488.

* *Astr. Nachr.*, No. 703.

COMPANION OF BIELA'S COMET.

Date.	M. T. Wash'n.	☄'s apparent α	☄'s apparent δ	Observer.	✱'s Mean Place, 1850.0. α	✱'s Mean Place, 1850.0. δ	Mag.	Authority.
1846	h. m. s.	h. m. s.	° ′ ″		h. m s	° ′ ″		
Feb. 12	6 43 57.3	1 41 54.51	—3 55 54.50	M.	1 39 27.73	—3 51 57.98	8	Weisse I. 715, and Wash. Obs.
	6 43 57.3	1 44 53.62	3 55 52.35	M.	1 40 2.72	3 59 35.13	9	" I. 727, " "
	6 52 30.8	1 41 56.65	3 55 59.70	M.	1 45 11.05	3 51 38.36	9	" I. 813, " "
13	7 17 1.8	1 49 36.06	4 8 45.60	W.	1 52 40.63	4 5 50.45	7.8	" I. 942, " "
16	6 54 19.8	2 3 50.82	4 49 0.65	M.	1 59 29.92	4 56 2.09	8	" I. 1069, " "
	7 1 44.4	2 3 51.62	4 48 59.83	M.	2 8 23.47	4 47 35.17	8.9	" II. 120, " "
	7 1 44.4	2 3 51.86	4 49 0.65	M.	2 10 42.69	4 47 38.90	8.9	" II. 159, " "
21	7 47 59.1	2 29 48.61		M.	2 26 39.33	6 17 49.14	8	" II. 443, " "
	7 47 59.1	2 29 48.60		M.	2 28 4.70	6 19 44.87	9	" II. 475, " "
March 8	8 19 53.4	4 6 0.24	10 43 42.37	W.	4 6 21.84	10 46 17.17	7	Maclear 21, " "
	8 23 30.8	4 6 1.88	10 43 49.22	W.	4 7 15.73	10 37 55.34	5	B. A. C. 1303, " "
10	8 17 8.3	4 21 15.52	11 20 38.39	W.	4 21 49.14	11 23 24.00	7.8	Lalande 8479.
17	8 11 45.3	5 18 40.23	—13 12 53.26	M.	5 18 44.63	—13 15 58.55	7.8	Maclear 33, and Wash. Obs.

Observations of Relative Position of the Two Comets.

(Companion — Biela.)

Date.	M. T. Washington.	Δ α	Δ δ	Date.	M. T. Washington.	Δ α	Δ δ
	h. m. s.	s.	′ ″			s.	′ ″
Jan. 14	6 51 42.4	—4.00	+1 9.07	Feb. 13	7 17 1.8	—8.67	+4 38.43
18	7 27 57.6	4.46	1 48.16	16	7 18 55.8	9.61	5 5.45
19	6 37 45.1	4.33	1 46.32	18	7 32 55.8	9.98	5 17.91
22	7 0 46.6	5.50	1 53.60	21	7 27 30.1	11.76	5 54.50
23	7 15 14.2	5.14	2 0.79	22	7 10 38.6	12.12	6 4.53
24	7 16 13.8	5.49	2 3.94	26	7 46 24.5	14.84	6 50.06
26	6 51 19.7	5.48	2 20.73	March 3	8 51 35.3	19.47	7 36.16
28	6 57 26.7	5.65	2 27.30	4	9 1 46.5	20.66	8 11.89
Feb. 4	6 30 59.3	6.25	3 10.97	5	8 30 33.6	22.50	8 7.99
5	6 59 55.7	6.53	3 22.27	8	8 14 28.2	25.25	
9	6 54 16.7	7.44	4 2.39	10	8 17 8.3	27.26	
11	7 54 17.1	7.72	4 4.60	14	8 30 11.7	32.90	9 10.94
12	7 3 40.4	—7.99	+4 30.57	21	8 42 20.9	—43.10	+8 45.25

(*To be continued.*)

NOTICE.

A "Universal Dictionary of Weights and Measures," by Mr. J. H. Alexander, has been published in Baltimore. Its object is to give the reduction of all known weights and measures, ancient and modern, to the standard measures of the United States. This work supplies what has long been needed by the scientist, as well as the man of business, and will be important to both. The value of the work would be still farther increased if, in a second edition, the authorities which have furnished the data should be cited.

G.

Corrigendum.

Page 119, line 6, *for* — ′ 13″.82, *read* —5′ 13″.82

CONTENTS.

THE

ASTRONOMICAL JOURNAL.

No. 18.

VOL. I. CAMBRIDGE, NOVEMBER 4, 1850. NO. 18.

COMET OBSERVATIONS.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL, IN 1845–46.

Communicated by Lieutenant MAURY, Director of the Observatory.

[Corrected for refraction only.]

(*Continued from page* 136.)

DE VICO'S COMET (1846 II.).

Date.	M. T. Wash'n.	☄'s apparent α	☄'s apparent δ	Observer.	*'s Mean Place, 1850.0. α	*'s Mean Place, 1850.0. δ	Mag.	Authority.
1846.	h. m. s.	h. m. s.	° ′ ″		h. m. s.	° ′ ″		
March 3	7 49 57.0	1 0 17.77	+11 17 33.74	M.	0 59 21.19	+11 16 35.10	9	Weisse O. 1052.
	7 51 43.3	1 0 16.70	11 17 47.61	M.	1 0 8.22	11 15 58.50	9	" O. 1065.
	7 51 43.3	1 0 16.96	11 17 43.39	M.	1 1 22.98	11 13 43.75	8	" I. 1.
4	7 30 21.9	1 0 2.21	12 46 43.27	M.	0 59 53.10	12 52 21.67	9	Filar-Micrometer.*
5	7 7 15.1	0 59 43.43	14 14 4.73	M.	0 57 10.68	14 8 17.60	6	B. A. C. 305.
8	6 58 31.3	0 58 22.57	18 28 35.34	M.	0 58 30.16	18 36 20.49	8.9	Bessel, Z. 378.
10	7 20 30.7	0 57 9.53	21 9 49.57	M.	1 0 5.17	21 10 33.81	8	" Z. 200, 392.
11	7 24 18.5	0 56 27.47	22 27 15.44	M.	0 58 35.39	22 25 55.10	9	" Z. 392.
14	7 21 42.1	0 51 3.56	26 8 18.51	M.	0 49 10.99	26 11 9.89	6	" Z. 388.
17	7 16 5.1	0 51 14.34	29 33 46.85	M.	0 49 51.06	29 30 24.05	8.9	Rümker 232.
21	7 17 9.3	0 46 57.70	33 46 10.98	M.	0 47 9.01	33 42 47.83	8	Bessel, Z. 439.
22	7 22 17.2	0 45 48.91	34 45 40.49	M.	0 47 33.42	34 55 28.52	8.9	" Z. 446.
30	7 59 29.5	0 35 34.87	42 2 15.86	M.	0 34 31.12	42 5 0.59	9	" Z. 443.
	8 10 8.5	0 35 34.05	42 2 36.12	M.	0 48 7.92	42 9 52.21	7	Rumker 225.
31	7 49 18.0	0 34 11.66	42 52 14.97	W.	0 34 9.17	43 6 53.63	7.8	Bessel, Z. 443, 444.
April 20	14 18 16.5	23 58 1.62	57 58 11.75	W.	0 1 12.07	58 19 21.60	6	B. A. C. 7.
27	12 6 33.9	23 38 37.71	62 42 1.90	W.	23 43 6.74	62 54 37.20	8	Radcliffe Observations.
	12 6 33.9	23 38 38.10	62 42 2.35	W.	23 40 51.63	62 59 3.56	8	" "
May 2	12 26 50.6	23 19 34.22	+66 0 59.49	W.	23 19 17.61	+66 5 49.93	7.8	Washington Observations.

BRORSEN'S COMET (1846 VII.).

Date.	M. T. Wash'n.	☄'s apparent α	☄'s apparent δ	Observer.	*'s Mean Place, 1850.0. α	*'s Mean Place, 1850.0. δ	Mag.	Authority.
1846	h. m. s.	h. m. s.	° ′ ″		h. m. s.	° ′ ″		
May 25	9 39 30.0	6 55 19.46	+44 32 52.71	M.	6 58 16.12	+44 29 23.66	8	Radcliffe Observations.
27	9 34 51.0	6 58 17.03	42 49 23.31	W.	7 10 26.98	42 55 44.97	6.7	" "
	9 34 51.0	6 58 17.06	+42 49 23.87	W.	7 12 8.44	+42 56 29.61	9	" "

* Compared with Weisse O. 1064 and 1069.

ON THE ORBIT OF α VIRGINIS, REGARDED AS A DOUBLE STAR.

By PROFESSOR PEIRCE.

Mr. Schubert's investigations upon the apparent irregularities in the motions of *Spica* are so important, from their tendency to confirm Bessel's hypothesis, that there are large dark bodies connected with the visible stars, as to deserve a critical examination. The first question to be answered is, whether the discrepancies between observation and the theory of the *Tabulæ Regiomontanæ*, which are contained in the second column of the following table, are not attributable to familiar and admitted causes, such as the star's proper motion and the error of its mean place, combined with the customary errors of observation. For the solution of this inquiry, I have determined, by the method of least squares, the most probable proper motion and correction of the right-ascension of *Spica*, and find them to be, —

The correction of α for 1800 $= -0^s.070$
The annual proper motion in $\alpha = +0^s.00143$.

In making this computation, I have given the weight of ten years of observation to Bessel's place for 1825. The residual errors, after making allowance for these corrections, are contained in the third column of the table; and it may be seen by inspection, that they are not so large as decisively to exclude the hypothesis, that they are simply errors of observation; while they are certainly too small and irregular to authorize any vague or strange speculation. It cannot, therefore, be inferred that they justify Bessel's hypothesis, without it can be definitely shown that such an hypothesis actually diminishes their amount. But since the real errors of observation cannot be much smaller than the numbers of the second column, these numbers can only lead to a rough approximation to the orbit of *Spica*. I have, therefore, contented myself with supposing, after a few rapid trials, this orbit to be a circle parallel to the plane of the celestial equator, having a period of revolution of forty-four years, and a radius of $0''.90$, which was directed towards our solar system in the year 1838. The correction of right-ascension to be applied to the mean place of the star for such an orbit is contained in the fourth column of the table. By the application of these corrections, and of the corrections arising from a new determination of the star's absolute place, and of its mean proper motion, the residual errors are deduced which are contained in the fifth column of the table. The new determination of the place and proper motion of *Spica* give

The correction of α for 1800 $= -0^s.085$
The annual proper motion in $\alpha = +0^s.00193$.

It will be seen that the sum of the squares of the errors is reduced, by the assumption of the orbit, from .075935 to .035942; the corresponding probable error of a year's observation being reduced from $0^s.043$ to $0^s.030$. The numerical argument in favor of the proposed theory is, then, stronger than two to one, which would be decisive of the question, if the arguments from analogy and novelty of the hypothesis might be regarded as nearly balanced. It is a confirmation of the numerical results, that the numbers of the third column give for the probable error of each year's observation previous to 1825 the same value which they give for each subsequent year, which is wholly opposed to what we know of the improvements in the instruments and methods of observation. But, on the contrary, the numbers of the fifth column give $0^s.034$ for the probable error of a year's observation previous to 1825, and $0^s.025$ for that of a subsequent year's observation. This result would make a modern year's series of observations about 60 per cent. more valuable than that of an ancient year, which is quite consistent with what we should anticipate. On the whole, then, the weight of the argument appears to be in favor of the supposition that *Spica* is moving around some center, which is not far distant from it; and the attention of practical astronomers is urgently invited to a course of investigation which shall settle this delicate problem.

Year.	Observation less Theory of *Tab. Reg.*	Residual Error after subtracting Proper Motion and Correction of Place	Motion for Supposed Orbit.	Residual Errors	Year.	Observation less Theory of *Tab. Reg.*	Residual Error after subtracting Proper Motion and Correction of Place	Motion for Supposed Orbit.	Residual Errors.
	s.	s.	s.	s.		s.	s.	s.	s.
1766	−0.123	−0.005	−0.039	+0.066	1789	−0.127	−0.042	+0.039	−0.059
1770	−0.136	−0.043	−0.017	+0.004	1791	−0.082	+0.001	+0.025	−0.004
1773	−0.111	−0.002	+0.008	+0.019	1795	−0.165	−0.088	−0.008	−0.062
1775	−0.150	−0.045	+0.025	−0.042	1797	−0.091	−0.017	−0.025	+0.025
1778	−0.098	+0.003	+0.042	−0.003	1800	−0.122	−0.052	−0.043	+0.008
1779	−0.120	+0.019	+0.047	−0.040	1802	−0.130	−0.063	−0.054	+0.005
1780	−0.061	+0.038	+0.051	+0.009	1825	0.000	+0.034	+0.058	−0.020
1783	−0.026	+0.069	+0.060	+0.033	1835	+0.016	+0.036	+0.025	−0.009
1784	−0.051	+0.040	+0.060	+0.003	1836	+0.001	+0.020	+0.017	0.000
1785	−0.025	+0.066	+0.058	+0.031	1837	+0.023	+0.040	+0.008	+0.028
1787	−0.095	−0.006	+0.050	−0.034	1838	−0.025	−0.009	0.000	−0.013

Year.	Observation less Theory of *Tab. Reg.*	Residual Error after subtracting Proper Motion and Correction of Place	Motion for Supposed Orbit.	Residual Errors.	Year.	Observation less Theory of *Tab. Reg.*	Residual Error after subtracting Proper Motion and Correction of Place	Motion for Supposed Orbit.	Residual Errors.
	s.	s.	s.	s.		s.	s.	s.	s.
1839	+0.006	+0.020	—0.008	+0.023	1844	—0.073	—0.066	—0.045	—0.028
1840	+0.019	+0.032	—0.017	+0.044	1845	—0.037	—0.031	—0.050	+0.011
1841	+0.026	+0.037	—0.025	+0.056	1846	—0.099	—0.095	—0.054	—0.049
1842	—0.017	—0.007	—0.033	+0 020	1847	—0.083	—0.080	—0.058	—0.031
1843	—0.075	—0.066	—0.039	—0.031					
		Sum of squares of errors,				0.235180	0.075935		0.035942
		Probable error of one year's observation,				0ˢ.077	0ˢ.043		0ˢ.030

Note. The errors of the fifth column seem to have a period of about twenty years, or half the period of revolution, which would correspond to the effects of eccentricity of the orbit; but the present state of the observations does not authorize so refined an investigation as that of the eccentricity.

LETTER OF MR. BOND TO THE EDITOR.

Cambridge, October 17, 1850.

There seems to be some misapprehension in regard to the name (*Victoria*) which Mr. Hind has proposed to astronomers to distinguish his latest discovered planet.

Victoria was the daughter of Pallas,* and one of the attendants of Jupiter, and therefore the name appears to fulfil the required conditions of a mythological nomenclature.

The incidental circumstance of the Queen of England bearing the same name ought not surely to weigh with American astronomers in opposition to the wishes of Mr. Hind, who, by his skilful and laborious researches, has added three new planets to our knowledge of the solar system.

W. C. BOND.

P. S. In the event of the name Victoria being rejected by foreign astronomers, Mr. Hind has another name, *Clio*, to which the same symbol, a star and laurel-branch ( ), would apply equally well.

* A giant, — not the goddess, who is believed to have left no children. G.

It is with regret that the Editor differs from Mr. Bond's authority, but he has reason for believing that the opinion of astronomers in this country is very decidedly opposed to the adoption of the names of sovereigns or other individuals in astronomical nomenclature. There can be no doubt that Mr. Hind's zealous and successful labors not only have invested him with the right to propose names for the planets he has discovered, but entitle every expression of his wishes to great consideration. The name *Clio* can hardly fail to meet with general acceptance. The symbol proposed by Mr. Hind is a star surmounted by a laurel-branch, not surrounded by the laurel-*wreath* of Victory, as stated on page 134.

FROM A LETTER OF PROFESSOR BUSCH, DIRECTOR OF THE KÖNIGSBERG OBSERVATORY, TO THE EDITOR.

Königsberg, 1850, *July* 27.

I inclose you for the *Astronomical Journal* some observations of the occultations of *α Tauri*, April 15, and of *Jupiter*, May 19, 1850, by the moon.

The occultation of *α Tauri* was observed as follows: —

	Königsberg S. T.	Observer.
	h. m. s.	
Immersion, April 15	10 57 43.7	Busch.
	43.9	Dr. Wichmann.
	43.4	Mr. Marth, stud.
Emersion,	11 47 47.6	Busch.

The observation was made by me with a dialytic telescope by Plössl, of four inches aperture, by Dr. Wichmann with the heliometer, and by Mr. Marth with a smaller Fraunhofer telescope. The attention of each of us was especially directed to the observation of any phenomena attending the disappearance of the star; but all three observers saw the star, without any gradual diminution of light, *suddenly* vanish, while in its full brilliancy, without leaving the slightest trace. Dr. Wichmann thought, indeed, that he could perceive repeatedly, some

seconds before the disappearance, a momentary decrease of the light, yet this diminution was but momentary and transient. Since the moon was very near the horizon at the time of the emersion, and the color of its light was scarcely distinguishable from that of the star — I suspect, as I did not see the emersion occur suddenly, that the time given for the observed emersion may be, perhaps, a little too late.

The occultation of *Jupiter* was observed by me while in Dantzic, at the Royal Navigation School of that city, with an equatorial Fraunhofer telescope of four inches aperture belonging to the school. Mr. ALBRECHT, Director of the institution, had the kindness, not only readily to allow me the use of this instrument, but also to determine for the purpose the correction of TIEDE's clock, No. 78, by corresponding altitudes of the sun. The passing clouds and foggy atmosphere, nevertheless, only allowed the observation of *Jupiter's* second limb.

	Dantzic S. T. h. m. s.
Immersion ♃, II.	11 53 12.2
Emersion " "	13 4 21.7

The last observation I do not consider so reliable as the first.

BUSCH.

OBSERVATIONS OF THE SECOND COMET OF 1850, AND OF PARTHENOPE.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

BY MR. JAMES FERGUSON.

Communicated by Lieutenant MAURY, Director of the Observatory.

[Corrected for refraction.]

SECOND COMET OF 1850.

Date. 1850.	M. T. Washington. h. m. s.	No. Comp.	Comparison Star.	☄ — * Δα m. s.	☄ — * Δδ ′ ″	☄'s apparent α h. m. s.	☄'s apparent δ ° ′ ″	A.
Sept. 16	13 35 44.8	14	Bessel, Z. 452	—0 25.84	— 9 24.33	7 45 22.78	+39 30 55.97	8
17	13 37 44.8	6	Rümker, 2390	—0 30.70	+14 16.62	7 55 42.91	+36 55 46.89	6
Oct. 4	16 54 3.9	7	Weisse X. 224	—2 16.70	— 4 7.36	10 10 55.38	— 4 41 58.65	10
		7	" 229	—2 38.90	— 2 3.40	10 10 55.66	— 4 41 56.82	10
(1) 6	16 59 3.0	12	*a*	+0 18.87	— 8 51.59	10 21 28.47	— 7 44 34.74	9
(1) 7	16 42 56.6	5	Lamont's Zones, 33	—0 36.16	+ 8 3.58	10 26 57.90	— 8 56 13.92	8
8	17 3 19.9	7	Weisse X. 538	+1 15.21	+ 0 48.22	10 31 14.17	—10 15 14.94	9
		7	" 548	+0 54.95	+ 1 8.21	10 31 13.60	—10 15 12.04	9
9	17 7 28.9	3	*b*	+2 32.15	+ 0 9.71	10 36 23.84	—11 24 40.31	7
12	17 19 2.1	2	Weisse X. 879	+2 13.04	+ 3 23.54	10 50 17.20	—14 24 53.96	10

(1) Star of comparison doubtful.

On the 16th and 17th September, the comet faint. On the 4th October, and at the following observations, it was bright, much condensed, and nearly round. It would have been observed more frequently, but for the bright moonlight following the 17th of September, and the constant mists of the mornings in October.

Adopted Mean Places for 1850.0 *of Comparison-Stars.*

*	Mag.	α h. m. s.	δ ° ′ ″	Authority.
Bessel, Z. 452	9	7 45 47.79	+39 40 33.32	Bessel's Zones.
Rümker 2390	9	7 56 12.81	+36 41 42.87	Rümker's Catalogue.
Weisse X. 224	7	10 13 11.53	— 4 37 40.01	Weisse's Catalogue.
" 229	7	10 13 34.02	— 4 39 51.17	" "
a	9	10 21 9.08	— 7 35 41.33	W. Equatorial diff. from Lal. 20419.
Lamont's Zones 33	8.9	10 27 33.24	— 9 4 16.11	Lamont's Zones.
Weisse X. 538	9	10 29 58.41	—10 16 1.65	Weisse's Catalogue.
" 548	9	10 30 18.11	—10 16 18.76	" "
b	9	10 33 31.16	—11 24 48.70	W. Equatorial diff. from Weisse X. 520.
Weisse X. 879	9	10 48 3.65	—14 28 16.59	Weisse's Catalogue.

PARTHENOPE.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	Parthenope — Star $\Delta\alpha$	Parthenope — Star $\Delta\delta$	Parthenope's apparent α	Parthenope's apparent δ	A
1850.	h. m. s.			m. s.	′ ″	h m. s	° ′ ″	
Sept. 16	7 48 52.4	4	B. A. C. 5408	— 2 24.19	+ 6 16.99	16 3 37.31	—18 2 17.20	10
17	7 22 26.6	12	"	— 0 49.40	+ 0 2.12	16 5 12.14	—18 8 32.04	8
(1) 20	7 31 23.9	3	Lal. 29696	— 0 47.07	+ 0 11.96	16 10 7.31	—18 27 15.79	7
21	6 56 14.8	7	"	+ 0 49.09	— 5 46.49	16 11 43.45	—18 33 14.20	10
22	7 7 18.4	8	"	+ 2 29.93	—11 53.37	16 13 24.29	—18 39 21.05	10
23	6 59 2.4	5	"	+ 4 10.25	—17 52.62	16 15 4.57	—18 45 20.23	9
(2) 29	7 24 29.3	1	B. A. C. 5467	+10 4.67	+20 17.40	16 25 25.66	—19 20 32.26	10
Oct. 1	6 53 11.4	6	B. A. C. 5580	— 4 9.33	+ 6 16.30	16 28 55.38	—19 31 42.98	9
2	6 46 16.7	6	"	— 2 22.59	+ 0 48.26	16 30 43.19	—19 37 6.90	7
3	6 58 9.8	16	"	— 0 33.71	— 4 39.87	16 32 32.20.	—19 42 35.05	9
4	6 49 48.4	8	"	+ 1 13.80	— 9 59.94	16 34 19.70	—19 47 55.15	9
5	6 39 18.6	4	Lal. 30479	— 2 0.12	— 3 56.30	16 36 9.08	—19 52 58.47	7
6	6 47 42.5	14	"	— 0 9.08	— 9 11.59	16 38 0.12	—19 58 13.70	9
7	6 36 54.3	7	"	+ 1 38.98	—14 15.27	16 39 48.16	—20 3 17.34	8
8	6 41 25.0	5	B. A. C. 5663	— 2 56.41	+ 0 55.47	16 41 38.71	—20 8 41.43	8
(3) 9	6 31 36.2	4	"	— 1 5.65	— 4 1.49	16 43 29.86	—20 13 38.37	8

(1) Observed betwixt clouds. (2) Very few stars here. (3) Moon close to planet, which is not well seen.

Adopted Mean Places for 1850.0 *of Comparison-Stars.*

*	Mag.	α	Ann. Prec.	δ	Ann. Prec.	Authority.
		h. m. s.	s.	° ′ ″	″	
B. A. C. 5408	6.7	16 6 0.40	+3.456	—18 8 37.10	—9.57	B. A. Catalogue.
Lal. 29696	7	16 10 53.269	3.467	—18 27 30.84	9.192	Lalande's Catalogue.
B. A. C. 5467	5	16 15 19.94	3.500	—19 40 52.80	8.84	B. A. Catalogue.
B. A. C. 5580	7	16 33 4.712	3.514	—19 37 59.29	7.43	Madras Observations 2061.
Lal. 30479	8	16 38 8.17	3.522	—19 49 5.82	7.012	Lalande's Catalogue.
B. A. C. 5663	6.7	16 44 34.11	+3.535	—20 9 41.01	—6.48	B. A. Catalogue.

OBSERVATIONS OF THE COMET OF AUGUST 29, 1850, MADE AT THE CAMBRIDGE OBSERVATORY.*

Date.	M. T. Cambridge.	$\Delta\alpha$ ☄ — *	No. Obs.	$\Delta\delta$ ☄ — *	No. Obs.	*'s Mean Place, 1850.0. α	*'s Mean Place, 1850.0. δ	Mag.	Authority
1850.	h. m. s.	m. s.		′ ″		h. m s.	° ′ ″		
Aug. 29	11 9 45	+2 5.33	8	—3 43.4	3	3 22 44.31	+58 4 21.3	8.9	Arg. Zone 57, No. 125.
30	9 44 43	+1 32.52	8	+6 24.7	5	3 34 13.17	+58 0 54.5	9.10	
31	8 23 19	+1 9.82	8	—0 29.3	5	3 46 11.04	+58 10 46.4	8.9	Arg. Zone 68.
Sept. 2	10 0 38	+3 35.50	6	—6 31.5	6	4 11 7.70	+58 7 55.5	8.9	" 68.
3	10 17 38	—0 4.44	9	—7 51.2	8	4 29 8.53	+57 55 30.5	15	
8	13 28 0	+0 41.31	8	+2 32.0	2	5 47 40.92	+54 22 15.2	7.8	Arg. Zone 174.
8	14 33 0	+1 51.43	12	+5 51.5	3	5 47 10.63	+54 15 58.1	3	B. A. C. 1885.
10	12 46 38	+0 48.59	4	+1 0.6	1	6 18 42.86	+51 52 10.4	8.9	
11	10 57 2	—0 54.55	8	—5 10.4	2	6 31 40.72	+50 31 42.1	7	Arg. Zone 76, No. 119.
13	12 28 12	—2 4.70	8	+1 32.6	3	7 6 26.67	+43 25 2.4	8	H. C. 14014.
20	15 57 40	+0 24.02	6	—5 49.5	5	8 30 34.70	+28 26 10.4	9	
21	16 38 4	+1 21.98	4	+0 3.0	3	8 39 22.43	+25 24 52.1	9	
Oct. 1	16 47 48	+4 25.70	4	+0 9.1	1	9 19 43.33	+ 0 36 35.0	8	Weisse 1076.
6	17 10 28	+0 16.40	4	—8 14.3	4	10 21 2	— 7 30	8	Undetermined.
13	17 10 5	—0 2.35	5	—7 33.5	2	10 51 36	—15 9	8	"
14	17 12 12	+2 3.47	6	+1° 22.9	6	10 57 11	—16 4	9	"

* The series is given entire, as communicated by Mr. Bond. The observations, to September 8, are the same as in No. 15 of the *Astr. Journ.* — G

The observed differences are corrected for refraction.

PLACES OF THE COMET.

Cambridge M. T.		α 1850.0.	δ 1850.0.	Cambridge M. T.		α 1850.0.	δ 1850.0.
1850.	h. m. s.	h. m. s.	° ′ ″	1850.	h. m. s.	h. m. s.	° ′ ″
Aug. 29	11 9 45	3 24 49.67	+58 0 37.9	Sept. 10	12 46 38	6 19 31.45	+51 53 11.0
30	9 44 43	3 35 45.69	58 7 19.2	11	10 57 2	6 33 46.17	50 26 31.7
31	8 23 19	3 47 20.86	58 10 17.1	13	12 28 12	7 4 21.97	46 36 30.2
Sept. 2	10 0 38	4 14 43.20	58 1 24.0	20	15 57 40	8 30 58.71	28 20 20.9
3	10 17 38	4 29 4.09	57 47 39.3	21	16 38 4	8 40 44.41	25 24 55.1
8	13 28 0	5 48 22.23	54 24 47.2	Oct. 1	16 47 48	9 54 9.03	+ 0 36 44.1
8	14 33 0	5 49 5.06	+54 21 52.6				

The reduction of later observations is delayed until the stars of comparison can be determined.

August 29. The comet was first seen at 10ʰ 30ᵐ. It is quite faint and without concentration. The diameter of the brightest part is 1′ 30″.

August 30. The place of the star this evening was derived from that used on the 29th.

September 2. The differences of right-ascension and declination between the comet and star were imperfectly obtained, from their being frequently interrupted by clouds. The comet is increasing in size and brightness.

September 3. The star depends upon a star in Arg. Zones, No. 61.

R.A. $4^{h.}\ 29^{m.}\ 8^{s.}.03$

Dec. 58° 3 24″.4.

September 8. The star was also compared with B. A. C. 1885. The adopted position is the mean of the two authorities, which agree very closely. The comet is much brighter, and its light somewhat condensed.

September 10. The star depends upon the stars in Arg. Zone 163, Nos. 192 and 193.

September 13. The comet is now a much better object to observe than it has been on previous nights, though it has no nucleus.

September 20. The star was compared with a star in Bessel's Zone 352.

R.A. $8^{h.}\ 29^{m.}\ 7^{s.}.72$

Dec. 28° 20′ 1″.3.

September 21. The star was compared with a star in Bessel's Zone 352.

R.A. $8^{h.}\ 29^{m.}\ 7^{s.}.72$

Dec. +28° 20′ 1″.3.

Mr. G. P. Bond has computed the following continuation of the ephemeris in the *Astr. Journ.* No. 16. It will probably be visible through October, and part of November.

EPHEMERIS.

1850.	R.A.	Dec.	Log. △	1850.	R.A.	Dec.	Log. △
	h. m. s.	° ′			h. m. s.	° ′	
Oct. 16	11 4 48	—16 54		Nov. 1	12 15 1	—23 1	
17	11 9 22	17 35		2	12 19 7	23 11	
18	11 13 54	18 11	9.9364	3	12 23 11	23 19	0.0929
19	11 18 25	18 44		4	12 27 11	23 27	
20	11 22 56	19 15		5	12 31 7	23 34	
21	11 27 26	19 44		6	12 35 0	23 40	
22	11 31 54	20 12	9.9829	7	12 38 50	23 46	0.1209
23	11 36 21	20 37		8	12 42 36	23 51	
24	11 40 47	20 59		9	12 46 19	23 56	
25	11 45 11	21 20		10	12 49 58	24 0	
26	11 49 34	21 38	0.0244	11	12 53 34	24 3	0.1454
27	11 53 55	21 55		12	12 57 6	24 6	
28	11 58 13	22 10		13	13 0 35	24 9	
29	12 2 29	22 24		14	13 4 1	24 11	
30	12 6 43	22 38	0.0609	15	13 7 25	—24 13	0.1670
31	12 10 54	—22 50					

W. C. BOND.

Cambridge, October 22, 1850.

FROM LETTERS OF PROFESSOR SCHUMACHER TO THE EDITOR.

Altona, 1850, *October* 1.

Dr. Petersen has, on account of the unfavorable weather, been able to make but three observations of the new planet. The comparison-stars are yet wanting for one, the others are, —

	M. T. Altona. h. m. s.	α h. m. s.	δ ° ′ ″
Sept. 25	11 35 41	23 35 4.93	+12 10 55.2
30	10 54 19.7	23 31 30.55	+11 16 48.4

Professor Encke has sent me, —

	M. T. Berlin. h. m. s.	α ° ′ ″	δ ° ′ ″	
Sept. 20	9 11 53.6	354 46 37.2	+13 3 56.4	Refr.
	11 41 9.6	354 45 17.7	13 2 49.0	Merid.
21	9 27 18.0	354 31 14.8	+12 53 33.7	Refr.

Mauvais has sent me the following ephemeris for the comet, (under date of September 27) : —

	M. T. Paris. h. m. s.	☄ α ° ′	☄ δ ° ′	λ ° ′	β ° ′	Δ
Sept. 29	12 3 58.2	144 53.3	+ 5 34.3	145 17.9	— 7 58.7	0.4786
Oct. 4	4 39.5	152 10.9	— 4 3.3	155 40.2	14 29.2	0.5616
9	5 30.4	158 31.3	10 57.9	161 27.6	18 31.0	0.6638
14	6 30.6	164 20.6	15 32.7	171 54.7	20 26.8	0.7840
19	7 27.8	170 5.5	19 0.1	178 47.5	21 18.9	0.8997
29	9 26.5	181 3.5	22 31.7	190 19.2	20 9.8	1.1380
Nov. 8	11 11.5	191 1.0	23 55.0	199 43.2	17 36.0	1.3489
18	12 12 39.2	199 36.0	—24 20.3	207 22.4	—14 51.4	1.5251

The comet has had five discoverers.* The fifth is Mr. Clausen in Dorpat, September 14.

Peters in Königsberg has already completed the same investigation for *Sirius*, which Schubert, certainly without being aware of this, has also made. You will find the numbers in the number of the *Astronomische Nachrichten*, which is now printing [No. 634]. The residual differences (from 1755 to 1847) only vary in the hundredths of seconds of arc. The seven stars which Struve compared with *Sirius* now agree even better than before. . . . . . I cannot see, indeed, why all the fixed stars should necessarily possess light of their own. If they do not, and can send us only reflected light, they must evidently be invisible to us on account of their great distance. How faint even *Neptune* is, and what is *Neptune's* distance compared with that of the fixed stars !

1850, *October* 7.

Professor Peters has also sent me the following data from his memoir on the variability of *Sirius*.

Mean annual motion of *Sirius* in its orbit =	7°.3104
The period, therefore,	49y.245
Passage of *Sirius* through the inferior apsis, A.D.	1792.819
Eccentricity of the orbit	0.5647

From the observations of right-ascension only five elements of the orbit can be determined, and two remain undetermined, which can only be deduced by discussing the observations of declination. It is very desirable that some southern Observatory (Chili ?) should compare *Sirius* in declination also with the neighboring stars for a series of years.

If for a time t we call the eccentric anomaly of *Sirius*, reckoned from the inferior apsis, $= u$, and the correction which must be applied to a right-ascension of *Sirius* in the *Tabulæ Regiomontanæ*, — in order that the difference between this corrected computed right-ascension and the mean of the tabular right-ascensions of *β Orionis*, *α Orionis*, and *Procyon* may be equal to the observed differences of right-ascension between *Sirius* and these last three stars, — be put $= x$, we have,

$$x = 0''.101 + 0''.00072\,(t - 1800) + 0''.170 \sin (u + 92°\ 18').$$

H. C. SCHUMACHER.

ELEMENTS AND OBSERVATIONS OF CLIO.†

From the observations of the new asteroid made at London, September 13, Berlin, September 21, and Altona, September 30, I have computed the following approximate elements. If they are worthy of reliance, the period of *Clio* is shorter than that of any other asteroid, with the single exception of *Flora*.

* Mr. Bond still retains his priority.— G.

† This name is provisionally adopted, as having been proposed by Mr. Hind.

Clio. — 1850, September 21.5.

Mean Equinox, — Berlin Mean Time.

M	38° 46′ 40″.8
ω	64 41 50.0
☊	235 27 8.1
i	8 26 14.8
ϕ	13 0 8.4
μ	16′ 23″.7927

Hence we have $a = 2.35181$, and a period of 1317.35 sidereal days.

Lieutenant Maury has sent me an observation of the planet at Washington, October 28, by comparison with a star whose mean place for 1850.0 was determined with the equatorial by means of Weisse XXIII. 452.

$$* \alpha = 23^h\,25^m\,0^s.74 \qquad * \delta = +6°\,41'\,13''.66$$

Mr. Ferguson found for *Clio*, —

M. T. Washington.		No. Comp.	☿ — * $\Delta\alpha$	☿ — * $\Delta\delta$	☿ α	☿ δ
	h. m. s.		m. s.	′ ″	h. m. s.	° ′ ″
Oct. 28	10 11 13.73	10	—1 44.69	—5 45.9	23 23 18.63	+6 35 47.3

Professor Schumacher has also sent (Oct. 11), the following observations made by Dr. Petersen with the meridian-circle.

1850.	M. T. Altona.	☿ α	☿ δ
	h m. s.	° ′ ″	° ′ ″
Sept. 30	10 54 19.7	352 52 38.3	+11 16 48.8
Oct. 2	10 45 9.9	352 33 5.9	+10 54 39.4
Oct. 6	10 27 7.2	351 58 11.9	+10 10 15.2
7	10 22 10.1	50 21.0	9 59 17.1
8	10 18 14.9	43 3.5	48 18.5
9	10 13 51.3	351 36 6.6	+ 9 37 25.4

G.

NOTICE.

The twenty-ninth part of the *Königsberg Observations* has lately been published, containing the observations made by Professor Busch and Dr. Wichmann during the year 1846. Those of the years 1839 – 1845 will follow, in four successive parts. On account of their immediate interest, the heliometer observations of *Neptune*, of sixteen comets, and of five new asteroids, in the years 1846 – 1848 are added. Bessel's hitherto unpublished method of reducing the heliometer observations (alluded to by Dr. Wichmann, *Astr. Nachr.*, XXIV. p. 311), is also given. G.

CORRIGENDA.

Mr. Walker requests the readers of the Journal to make the following corrections: —

Page 130, line 5, in (b'), for $\frac{s+n}{n+1}$, read $\frac{n+1}{s+n}$.

Page 131, line 5, for $(\mu+1.\mu\ldots.2)$ read $(\frac{\mu+1.\mu\ldots.2}{1.2\ldots.\mu})$.

" 131, " 16 and 20, instead of the two forms of the general theorem, read as follows: —

VII. $$\alpha^m D_\alpha^m b_s^{(i)} = \Sigma_{\nu=0}^{\nu=\mu-1} \beta^{2\nu+2} . \Delta^\nu\, {}^m_0\mathrm{N}_s^{(i)}\, \alpha^{k+m-2} + \Sigma_{n=0}^{n=+\infty} \beta^{2\mu} . \Delta^\mu\, {}^m_n\mathrm{N}_s^{(i)}\, \alpha^{k+m}$$

VIII. $$\alpha^m D_\alpha^m b_s^{(i)} = \Sigma_{\nu=0}^{\nu=s-\frac{1}{2}} \beta^{2\nu+2} . \Delta^\nu\, {}^m_0\mathrm{N}_s^{(i)} . \alpha^{k+m-2} + \Sigma_{n=0}^{n=+\infty} \beta^{2s-1} \Delta^{s+\frac{1}{2}}\, {}^m_n\mathrm{N}_s^{(i)}\, \alpha^{k+m}$$

CONTENTS.

THE

ASTRONOMICAL JOURNAL.

No. 19.

VOL. I. CAMBRIDGE, NOVEMBER 21, 1850. NO. 19.

ON THE FIFTH COMET OF THE YEAR 1847.

By B. A. GOULD, Jr.

(*Continued from page* 83.)

An ephemeris deduced from these elements satisfied the series of observations tolerably well, but even the slight change of the parallax for the fundamental places, which was due to the more accurate determination of the comet's distances, was sufficient to change materially the form of the resultant orbit and the period deduced. During the fifty-four days over which our observations extend, the comet described less than forty minutes of mean anomaly, and from a mean daily sidereal motion of 43″, it is necessary to ascend to a motion of more than 17° of eccentric, and 113° of true anomaly. A twofold obstacle to precision in the ephemeris is thus presented, — first, in the determination of the eccentric anomaly from the mean, and secondly, in that of the true anomaly, or of the coördinates with reference to the equator, from the eccentric anomaly. The following elements represent the comet's places for July 21 5 and August 17.0, Berlin mean time, and Mr. Rümker's last observation at Hamburg.

Elements III.

Mean Equinox 1847.0, Mean Berlin Time.

T	1847, Sept. 9.55281
☊	309° 50′ 22″.53
i	19 8 59.87
ω	129 18 4.75
ϕ	76 53 17.77
μ	43″.77542

whence we have,

e	0.9739298
a	18.729125
Period	81.0543 sidereal years

and the following expression for the equatorial coördinates : —

A. Apparent equinox of 1847, July 19.

$$x = [9.9857705].r.\sin(v + 170^\circ\ 45'\ 42''.7) = [0.6984307]\sin(E + 144^\circ\ 21'\ 36''.6) - 2.8339614$$
$$y = [9.9151032].r.\sin(v + 70\ 23\ 31.8) = 0.4255909 - [1.4641205]\sin^2\tfrac{1}{2}(E + 355^\circ\ 22'\ 47.3)$$
$$z = [9.7938690].r.\sin(v + 99\ 52\ 46.7) = 0.3082137 - [1.3612665]\sin^2\tfrac{1}{2}(E + 2\ 15\ 45.0)$$

B. Apparent equinox of 1847, September 21.

$$x = [9.9857713].r.\sin(v + 170^\circ\ 45'\ 49''.8) = [0.6984057]\sin(E + 144^\circ\ 21'\ 57''.8) - 2.8333700$$
$$y = [9.9150995].r.\sin(v + 70\ 23\ 38.9) = 0.4255832 - [1.4641217]\sin^2\tfrac{1}{2}(E + 355^\circ\ 22'\ 49''.1)$$
$$z = [9.7938737].r.\sin(v + 99\ 52\ 50.3) = 0.3082178 - [1.3612701]\sin^2\tfrac{1}{2}(E + 2\ 15\ 45.9)$$

Since the beginning of this article was published, I have received and seen for the first time No. 662 of the *Astr. Nachr.*, containing a determination of the orbit of this comet by my valued friend Dr. D'Arrest. Had that number reached me earlier, I could not have omitted to refer to D'Arrest's elements,* and to his remark that this comet furnished another instance to be added to those of Santini and Brunnow, cited† by Encke, where the three fundamental observations were

* *Astr. Nachr.*, XXVIII p. 221. † *Ibid.*, XXVII p. 262.

equally well satisfied by two entirely different orbits. D'ARREST found, from places sixteen days apart, the following equation, at the fourth approximation, for determining the radius-vector at the middle observation: —

$$[0.057058] \sin^4 z = \sin (z - 4° \; 31' \; 33''.6).$$

Two of the roots of this equation, $z = 71° \; 21' \; 52''$, and $z = 105° \; 36' \; 25''$, answer all the required conditions. The former conducted him to an hyperbola, the latter gave him the elliptic elements to which reference is made on page 80.

My experience in determining the orbit of this comet, from an interval of fifty-three days, was very similar. The equation from which z was to be determined was, at the first hypothesis,

$$[9.9021264] \sin^4 z = \sin (z + 32° \; 53' \; 28''.5).$$

The four roots of this equation are,

$$z' = 95° \; 31' \; 43''.5$$
$$z'' = 117 \; 31 \; 13.1$$
$$z''' = 137 \; 38 \; 16.7$$
$$z'''' = 329 \; 58 \; 35.5$$

The third of these must correspond * to the earth's place, inasmuch as $\delta' = 133° \; 0' \; 31''$. But the first two equally fulfil the requisite conditions

$$\sin z > 0 \; , \quad \sin (\delta' - z) > 0.$$

At first I chose z'', and obtained the following remarkable orbit, which represents the three fundamental observations with entire precision: —

Mean Equinox 1847.0, Mean Berlin Time.
Epoch 1847, August 16.0.

M	266° 8′ 58″.3
☊	250 35 59.2
ω	229 5 34.9
i	4 24 4.0
ϕ	33 45 19.4
μ	1 45 22.7
a	0.6803589
e	0.5556484
Period	204.98 sidereal days.

* *Theoria Motus*, p. 158.

§ 4.

Reduced Observations.

Reducing the observations, given in § 2,* to Berlin mean time, and correcting the times for aberration and the places for parallax, we obtain the following series. The volume of Königsberg Observations for 1846, which was not published when these computations were made, contains a full reduction of the observations of this comet, after a new determination of the places of the comparison-stars. The comet-places there given have been substituted for those published in the *Astronomische Nachrichten* by Dr. WICHMANN. A comparison with the ephemeris derived from Elements III. is added. It will be seen that the computed right-ascensions and declinations are each too small during the first half of August; — but the three normal places were deduced with care, and are precisely represented.

* Page 81 *et seq.*

FIFTH COMET OF 1847.

Place.	Date.	α	δ	Authority.	C. — O. $\varDelta\alpha$	C. — O. $\varDelta\delta$
	d.	° ′ ″	° ′ ″		″	″
Altona,	July 21.531770	29 4 20.0		*Astr. Nachr.*, XXVI. p. 95	+ 4.1	
Altona,	.536945		27 1 29.1	" " XXVI. p. 95		— 8.3
Hamburg,	.549466	29 6 15.7	27 1 58.5	" " XXVI. p. 88	+ 0.9	+ 6.5
Altona,	.565148	29 7 58.2	27 3 1.8	" " XXVI. p. 95	— 1.7	0
Hamburg,	24.564582	34 50 3.8	30 4 7.4	" " XXVI. p. 96	— 9.0	— 24.5
Altona,	25.550622	36 53 10.3		" " XXVI. p. 95	+ 2.8	
Altona,	.561481		31 3 33.2	" " XXVI. p. 95		+ 16.7
Hamburg,	.575024	36 55 38.3	31 4 19.0	" " XXVI. p. 127	+ 42.4	+ 19.7
London,	26 555224	39 5 28.8	32 3 32.2	" " XXVI. p. 143	— 34.4	— 30.2
Hamburg,	.594110	39 9 21.8	32 4 50.6	" " XXVI. p. 96	+ 45.9	+ 28.9
London,	27.595854	41 13 8.1	33 1 55.4	" " XXVI. p. 143	+882.8	+139.2
London,	29.542443	46 6 11.9	34 52 56.0	" " XXVI. p. 143	+435.7	+109.7
Königsberg,	Aug. 1.526846	54 17 25.4	37 27 39.1	*Königsberg Obs.*, XXIX. pp. 85, 107	— 2.6	+ 18.7
Hamburg,	.558747	54 22 55.3	37 28 53.2	*Astr. Nachr.*, XXVI. p. 96	— 4.9	— 3.9
Königsberg,	2.489098	57 4 41.9	38 10 38.8	*Königsberg Obs.*, XXIX. pp. 85, 107	— 2.0	— 12.4
Hamburg,	.513981	57 9 8.1	38 11 46.5	*Astr. Nachr.*, XXVI. p. 127	— 4.8	— 16.5
London,	3.512776	60 8 15.7	38 52 18.3	" " XXVI. p. 175	— 21.7	— 5.0
Hamburg,	.533276	60 12 0.1	38 53 5.0	" " XXVI. p. 127	— 22.9	— 3.9
Hamburg,	4.503147	63 10 8.7	39 28 14.8	" " XXVI. p. 127	— 12.3	+ 0.8
Bonn,	5.515890	66 25 52.8	40 1 13.0	" " XXVI. p. 179	— 1.1	— 9.0

Place.	Date.	α	δ	Authority.	C. — O. Δα	Δδ
Berlin,	d Aug. 6.461014	° ′ ″ 69 20 42.2	° ′ ″ 40 25 37.8	*Astr. Nachr.*, XXVI. p. 176	″ — 5.2	″ —10.9
Hamburg,	.522127	69 32 58.6	40 26 57.2	" " XXVI. p. 127	—26.3	—13.0
Königsberg,	7.484276	72 38 46.8	40 47 13.4	*Königsberg Obs.*, XXIX. pp. 86, 107	— 7.9	—13.0
Bonn,	.519919	72 45 45.1	40 47 44.8	*Astr. Nachr.*, XXVI. p. 179	—11.0	— 6.1
Hamburg,	.599891	73 1 8.7	40 49 15.1	" " XXVI. p. 182	— 2.9	— 9.9
London,	.663677	73 13 45.8	40 50 24.3	" " XXVI. p. 175	—16.4	—22.0
Hamburg,	8.523522	76 2 21.7	41 3 13.3	" " XXVI. p. 182	—76.8	— 7.7
Hamburg,	9.520181	79 16 7.6	41 12 57.0	" " XXVI. p. 182	—29.6	—10.8
London,	.586734	79 29 0.8	41 13 25.5	" " XXVI. p. 175	—26.0	—41.2
Paris,	.602578	79 32 1.0	41 13 28.9	*Comptes Rendus*, XXV. 265	—19.5	— 9.9
Hamburg,	10.522609	82 30 47.9	41 17 1.8	*Astr. Nachr.*, XXVI. p. 182	— 4.2	—12.6
Paris,	.630786	82 52 3.6	41 17 3.9	*Comptes Rendus*, XXV. p. 265	—22.2	— 8.6
Königsberg,	11.470320	85 34 8.0	41 15 40.1	*Königsberg Obs.*, XXIX. pp. 86, 107	—21.3	—11.1
Hamburg,	.509336	85 41 19.3	41 15 25.9	*Astr. Nachr.*, XXVI. p. 182	— 3.4	— 6.5
Bonn,	.511018	85 41 42.5	41 15 20.9	" " XXVI. p. 179	— 7.2	— 1.9
Paris,	.666622	86 11 37.0	41 14 43.3	*Comptes Rendus*, XXV. p. 265	—12.4	— 7.5
Bonn,	12.520829	88 51 16.5	41 9 20.7	*Astr. Nachr.*, XXVI. p. 179	—14.0	—62.6
Hamburg,	.562244	89 2 5.9	41 8 9.1	" " XXVI. p. 182	—15.9	—14.9
Königsberg,	13.414628	91 47 19.3	40 57 12.2	*Königsberg Obs.*, XXIX. pp. 86, 107	—15.0	+ 0.8
Bonn,	.534613	92 4 6.6	40 56 47.4	*Astr. Nachr.*, XXVI p. 179	—22.1	—52.9
Hamburg,	.559174	92 8 27.9	40 55 35.8	" " XXVI. p. 182	—10.7	— 3.1
Hamburg,	14.558831	95 11 23.5	40 38 13.1	" " XXVI. p. 182	—13.8	+ 1.1
Bonn,	.637240	95 25 51.8	40 36 30.7	" " XXVI p. 179	—33.1	+14.7
Bonn,	15.635312			" " XXVI. p. 179		
Hamburg,	.635670	98 23 13.4	40 14 30.4	" " XXVI. p. 182	—12.7	— 2.9
Hamburg,	16.582313	101 6 56.8	39 49 34.1	" " XXVI. p. 182	—12.4	— 3.9
Bonn,	.599854	101 9 32.3	39 49 5.3	" " XXVI. p. 179	+11.5	— 4.8
Berlin,	17.547953	103 48 35.4	39 20 29.3	" " XXVI. p. 176	— 0.2	+ 1.3
Hamburg,	.583121	103 54 28.9	39 19 32.3	" " XXVI. p. 182	— 5.5	— 8.8
Bonn,	.613589	103 59 30.7	39 18 23.1	" " XXVI. p. 179	— 5.4	+ 2.1
Hamburg,	18.556554	106 31 38.9	38 46 52.6	" " XXVI. p. 182	+18.3	+ 9.1
Königsberg,	.570294	106 31 16.9	38 46 12.9	*Königsberg Obs.*, XXIX. pp. 86, 107	— 8.5	— 1.7
Bonn,	.619515	106 42 8.7	38 44 25.5	*Astr. Nachr.*, XXVI. p. 179	—13.3	+ 5.2
Königsberg,	19.462562	108 53 43.6	38 13 34.2	*Königsberg Obs.*, XXIX. pp. 86, 107	—53.1	+37.5
Hamburg,	.569926	109 10 9.0	38 9 31.3	*Astr. Nachr.*, XXVI. p. 182	+ 0.5	— 4.5
Hamburg,	20.570288	111 40 34.6	37 29 58.1	" " XXVI. p. 182	— 6.6	—22.6
Hamburg,	21.575685	114 5 23.7	36 47 41.5	" " XXVI. p. 182	+20.3	— 0.4
Königsberg,	22.560719	116 22 28.0	36 4 15.9	*Königsberg Obs.*, XXIX. pp. 86, 107	+ 1.1	— 5.1
Hamburg,	23.651888	118 48 17.4	35 13 51.9	*Astr. Nachr.*, XXVI. p. 182	— 3.9	—13.0
Hamburg,	26.582163	124 48 20.7	32 49 11.0	" " XXVI. p. 182	+15.1	+ 0.8
Hamburg,	Sept. 4.669539	140 0 21.6	24 34 57.9	" " XXVI. p. 200	+ 8.3	+ 7.7
Hamburg,	5.662924	141 26 39.2	23 38 42.6	" " XXVI. p. 200	+ 9.2	— 1.6
Hamburg,	12.675044	150 48 49.0	16 58 23.6	" " XXVI. p. 200	0	— 0.1

(*To be continued.*)

ON THE CLASSIFICATION AND SPECIAL POINTS OF RESEMBLANCE OF CERTAIN OF THE PERIODIC COMETS; AND THE PROBABILITY OF A COMMON ORIGIN IN THE CASE OF SOME OF THEM.

By PROFESSOR STEPHEN ALEXANDER,
COLLEGE OF NEW JERSEY.

The comets already recognized as being either certainly or very probably periodic may, with reference to the major axes of their orbits, be arranged for the most part in two classes, — the one class including the comets of short period, whose semi-axes are all nearly the same with those of the small planets between *Mars* and *Jupiter;* and the other class including the comets

whose mean distance or semi-axis is, in every case, somewhat less than that of *Uranus*, — a classification distinctly noticed by Mr. HIND (*Astr. Nachr.*, No. 721).

The orbits of the comets which, in the present state of our knowledge, are to be included in Class I., will be found also to resemble each other in several other respects. Their arrangement in the order of their mean distances is very nearly as follows: —

CLASS I. — COMETS OF SHORT PERIOD.

Motion in every Case Direct.

Designation.	Mean Distance.	
Encke's, ...	2.22	
1819, IV., ...	2.85	
1819, III., (*dist.* 3.16) probably the same with 1766, II., *dist.* 2.93,	Mean 3.05	agrees with periodic time.
1844, I., *De Vico's* (I.), . .	3.10	
1846, III., *Brorsen's* (I.), . .	3.15	
Biela's or *Gambart's*, . .	3.50	*divided into two at its last return.*
1843, III., *Faye's*, . .	3.81	

The motion of these comets, as already stated, is in every case *direct*. If the orbit of any one of the class be, moreover, selected as the plane of reference, the nodes of the others (ascending or descending, as the case may be) will be found to be arranged for the most part within very moderate limits. If the plane of the orbit of 1846, III. be selected for this purpose, — in which the nodes most closely group themselves, — the *nodes of the same description* (viz., all the ascending, or all the descending) will be found included in an arc of less than 35°.

The respective distances of the descending nodes in the orbit of 1846, III., reckoned from the *ascending node of that orbit in the ecliptic*, at the comet's last return, are approximately as follows, the inclinations of the other orbits to that of 1846, III. being also appended: —

Designation.	☋′	i'
1843, III.,	−18° 53′	35° 40′
1819, III.,	− 5 32	20 24
1844, I.,	+ 3 49	28 38
1819, IV.,	+ 9 57	23 0
Biela's,	+11 23	41 33
Encke's,	+16 0	40 12

The nodes would be still more closely arranged in a plane of reference situated nearly at right angles to the orbit of *Encke's Comet*, or to that of 1843, III., and intersecting the ecliptic not far from the ascending node of 1846, III. The comets in question, however, do not seem to have any physical relation to such a plane, or with any body moving in it. But with respect to the comet of 1846, III., in the plane of whose orbit the nodes of the others are arranged as already shown, it may be observed, that *it* is the very one of the seven (or eight rather) whose orbit, as suspected by Mr. HIND (*Astr. Nachr.*, No. 582), may have been changed (in 1842) by the action of *Jupiter*. When, also, the inclinations are considered, the orbits may with some propriety be arranged in two groups; the one consisting of 1843, III., *Encke's*, and *Biela's*, with inclinations not deviating greatly from 39°; and the other group consisting of the orbits of the others, with inclinations not deviating very much from 24°.

May not, then, the whole seven (or rather eight) have formerly constituted one, or at most two, whose orbit or orbits were contracted by the disturbing action of Jupiter, — this action having been exerted at a time when the comets were thus combined?

After this, they may have been subdivided by a process as yet unknown, but similar to that by which one of their number (*Biela's*) was divided, almost under the eyes of the observers, at its last return, in 1846. The catastrophe or succession of catastrophes which divided some of them would seem to have been of quite an ancient date; since the nodes of the orbits of less inclination are included between those of greater.

However this may be, the points of resemblance which seem to indicate a common origin may be briefly recapitulated, as follows: —

1. Near approximation of semi-axes.
2. Direct motion in every case.
3. Close grouping of similar nodes.
4. Similarity of inclination of orbits thus grouped.
5. Actual division of *Biela's Comet*.

At a mean distance differing decidedly from either of the classes already specified, we find the comet of 1793, II., — probably the same with that of 1783, — and that of 1846, VI. (*Peters's*); whose mean distances do not greatly differ from that of *Jupiter*. These, if arranged at all, may furnish —

CLASS II.

Motion Direct.

1793, II., at mean distance, ...	4.65
1846, VI., " "	5.48

The ascending node on the ecliptic, of one of these, is more than 100° distant from the other, and the inclination of the one orbit differs about 17½° from that of the other; and their situation in these respects with regard to the orbit of *Jupiter* is very nearly the same.

The other comets already spoken of, whose mean distance is somewhat less than that of *Uranus*, are included in —

CLASS III.

(*a.*) *Motion Direct.*

Designation.	Mean Distance.
*1812 and 1672?	17.10
*1846, IV. (*De Vico's* IV.), ...	17.51
*1815 (*Olbers's*), ...	17.75
1847, V. (*Brorsen's* III.), ...	17.78
(*b.*) *Motion Retrograde.*	
Halley's, ...	17.99

The comet of 1812 somewhat resembles that of 1672. The interval between their perihelion passages is, moreover, very accurately twice the periodic time.

The planes of the orbits of the three comets to whose designations an asterisk is prefixed, all intersect the ecliptic within a distance of about 9°; the descending node of 1812 being found in the region of the ascending nodes of the other two. About 7° south of this arc of 9°, in longitude about 77°, the intersection of the planes of the three orbits exhibits a small triangle, whose sides are approximately, —

In plane of 1812,	. . .	2° 51′
1815,	. . .	1 33½
1846, IV.,	. . .	3 50½

A similar triangle is, of course, to be found on the opposite side of the heavens.

The position of the plane of 1815 is intermediate to that of 1812 and that of 1846, IV.; the inclination of 1812 to 1815 being 61° 37′ at its descending node on 1815, and 1846, IV. inclined 40° 44′ at its ascending node.

Such are the resulting dimensions, &c., of the triangle, the elements of the orbit of 1846, IV., at its last return, being assumed to be those obtained by Mr. DEINSE (*Astr. Nachr.*, No. 715); allowance being of course made for precession in the comparison of the elements with those of the other two comets, which are referred to different epochs. But if we assume for the elements of 1846, IV. the mean of those given in Mr. GALLE's *Table* in ENCKE's *edition* of OLBERS's *Abhandlung*, &c., and so also for the other comets, the sides of the triangle will each be but about two thirds as large, with almost no change in the angles.

The distances from the sun or radii vectores of the orbits which point to the middle of each side of the triangle are respectively, —

$$\left.\begin{array}{lr} \text{For 1812,} & 0.899 \\ \text{1846, IV.,} & 1.075 \\ \text{1815,} & 2.053 \end{array}\right\} \quad \ldots \quad (A)$$

The mean of the first two is but very little greater than the earth's perihelion distance; while the third considerably exceeds the mean distance of *Mars*.

If we suppose, as is most probable, that the nearest approach of the nodes in time past was a few degrees in advance of its present position, viz., on the ecliptic, — when also the nodes may have been still nearer to each other, — then (with the present position of the perihelion, and inclination) we shall have as the radii vectores, —

$$\left.\begin{array}{lr} \text{For 1812,} & 0.959 \\ \text{1846, IV.,} & 0.974 \\ \text{1815,} & 1.823 \end{array}\right\} \quad \ldots \quad (B)$$

The mean of the first two of these (0.966) differs from *the present perihelion distance of the earth* (0.983) *by about* 0.017, *or the eccentricity of the earth's orbit, and the place of concourse on the ecliptic here supposed would be but a few degrees short of the earth's perihelion.*

The mean, however, of the distances (A) is 1.342, which differs but 0.182 from the mean distance of *Mars*. The radii vectores *in the plane of Mars's orbit* are, —

$$\left.\begin{array}{lr} \text{For 1812,} & 0.966 \\ \text{1846, IV.,} & 0.964 \\ \text{1815,} & 1.790\tfrac{1}{2} \end{array}\right\} \quad \ldots \quad (C)$$

A relative change in the direction of the perihelion on the plane of the orbit,

For the comet of 1812, of about	+37°	4½′
1846, IV.,	+30	5
1815,	—15	55

would render the radii vectores *in the plane of Mars's orbit* all equal, and all equal to *Mars's* mean distance, i. e. his distance, moreover, in this portion of his orbit; and the point of concourse would be but a fraction of a degree still farther in advance of the position on the ecliptic.

These circumstances would *seem to indicate that a collision of Mars with a large comet took place in this region;* it remains to be seen whether the history of past observations can furnish any traces of the same thing.

Either of the comets in question might, with a supposable allowance for perturbations, be regarded as a return of the comet of 1315 and 1316.

Now, with regard to this latter comet, we may gather from PINGRÉ's *Cometographie* (Tome I., pp. 426, 427), —

1. That the comet was very large.*

2. That it was seen in December or a little later, when the earth as seen from the sun is in Cancer, and passing the region of concourse of the orbits already described.

3. The comet was seen in that region.

4. *Mars* was seen very near it according to some; according to others in conjunction with it; and according to Mr. PINGRÉ's own computation was certainly in the region at the time.

5. More than one comet was seen; the first the larger of two.

6. One of the comets had a great inclination to the ecliptic, and proceeded northward; and the comet 1846, IV. has an inclination of 85°, and its visible path would not be very much influenced in that respect by annual parallax; its ascending node would also be in that region.

To these we may add: —

7. That the misty appearance of *Mars* is also a fact in place, upon the hypothesis of a collision with a comet: though that alone might be quite insufficient to account for all the indistinctness which he exhibits.

8. The periodic times, &c., of the three comets, as already

* "D'une grandeur prodigieuse."

stated, may admit of the supposition that they were all in the region.

9. The comets while in that region are, all of them, on the same side of the perihelion (viz., approaching it), and near it.

These facts and coincidences, in so far as they go, agree in indicating a near appulse, *if not an actual collision of Mars with a large comet, in* 1315 *or* 1316; *that the comet was thereby broken into three parts, whose orbits (it may be) received even then their present form; viz., that still presented by the comets of* 1812, 1815, *and* 1846, IV., *which are fragments of the dissevered comet.*

However this may all be, there yet exist among the three comets the following points of resemblance, some of which have already been implied in what has before been stated: —

1. A very close approximation of the semi-axes.
2. An almost common node.
3. This last is in an analogous position on all the three orbits; viz., a little short of the perihelion.
4. The perihelion distances of two of the comets are nearly the same, and that of the third not very different from them.
5. The motion of all three is direct.

In the respects of perihelion distance, position of point of concourse with regard to the perihelion, and near approximation, even yet, of the radii vectores, the comets of 1812 and 1846, IV. are nearly the same, though the one is near its descending node in the ecliptic, and the other near its ascending node; while the comets of 1812 and 1815 returned to their perihelion more nearly at the same time.

The radii vectores of the comets are much less accordant in the region of the other triangle, which marks the nodes on the opposite side of the heavens. They extend to the region between the Asteroids and *Jupiter*.

In so far as the comets of 1812 and 1846, IV. alone are concerned, — from what is exhibited at (*B*), — the earth might well be regarded as the disturbing body.

OBSERVATIONS OF CLIO.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant Maury, Director of the Observatory.

[Corrected for refraction.]

Date. M. T. Washington.		No. Comp.	Comparison-Star.	☿ — * $\Delta\alpha$	☿ — * $\Delta\delta$	☿'s apparent α	☿'s apparent δ
1850.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
Oct. 28	10 11 13.7	10	*a*	—1 44.69	— 5 45.89	23 23 18.63	+6 35 47.4
29	8 44 58.6	10	Santini 1636	—1 11.02	+12 54.93	23 23 26.60	+6 28 46.4
	9 16 40.4	4	*a*	—1 36.24	—12 51.41	23 23 27.05	+6 28 41.9
31	7 39 36.4	14	Santini 1636	—0 48.41	— 0 59.31	23 23 49.19	+6 14 52.1
	10 13 1.8	4	"	—0 47.01	— 1 42.46	23 23 50.61	+6 14 8.9
Nov. 1	7 33 40.9	14	"	—0 34.08	— 7 42.03	23 24 3.52	+6 8 9.3
	8 28 54.9	6	"	—0 33.59	— 7 57.11	23 24 4.00	+6 7 54.3
2	8 15 7.6	5	"	—0 17.53	—14 24.55	23 24 20.08	+6 1 26.8
	9 0 1.5	5	"	—0 17.25	—14 36.47	23 24 20.45	+6 1 14.9
4	8 16 7.7	11	*b*	—0 37.28	—12 48.12	23 24 57.96	+5 49 9.2
	8 53 47.7	5	"	—0 36.56	—12 58.20	23 24 58.68	+5 48 59.2
5	7 48 52.7	4	B. A. C. 8177	+4 54.42	+ 9 46.38	23 25 18.56	+5 43 26.8
	7 52 26.8	6	W. C. XXIII. 458	+2 32.02	+ 7 8.44	23 25 18.73	+5 43 25.9

Adopted Mean Places for 1850.0 *of Comparison-Stars.*

*	Mag.	α	δ	Authority.	No. Comp.
		h m. s	° ′ ″		
a	9.10	23 25 0.74	+6 41 13.66	Diff. from W. C. 452, W. Equatorial.	8
(¹) Santini 1636	7.8	23 24 35.10	6 15 31.83	Santini's Catalogue, Memoirs Astr. Soc.	
b	9.10	23 25 32.76	6 1 37.97	Diff. from Santini 1636, W. Equatorial.	10
B. A. C. 8177	5	23 20 21.69	5 33 21.10	B. A. Catalogue.	
Weisse XXIII. 458	8.9	23 22 44.27	+5 35 58.17	Weisse's Catalogue.	

(¹) This star is the same as XXIII. 532 of Weisse's Catalogue, and is from Bessel's Zone 38. There is an error of one minute of time in the α, in Weisse. This has been made in the reduction from Bessel. The mean place for 1850.0 is as given above.

ZODIAC OF PARTHENOPE.

By PROFESSOR J. S. HUBBARD.

This zodiac of *Parthenope* is computed from the elements by Luther, given in No. 16 of the *Astronomical Journal*. The planet can be in the northern limit only between October 7 and November 25, and in the southern only between March 28 and May 17. The position of the moving star of Cacciatore does not occur in this zodiac, and the star must be therefore still excluded from the list of known asteroids.

α	δ North Limit.	δ South Limit.	α	δ North Limit.	δ South Limit.	α	δ North Limit.	δ South Limit.
0°	− 2° 44′	− 6° 43′	120°	+21° 35′	+18° 9′	240°	−13° 10′	−17° 46′
5	− 0 49	4 56	125	21 1	17 36	245	14 21	18 51
10	+ 1 8	3 6	130	20 18	16 55	250	15 24	19 48
15	3 5	− 1 17	135	19 28	16 3	255	16 20	20 36
20	5 0	+ 0 32	140	18 31	15 3	260	17 8	21 16
25	6 53	2 21	145	17 27	13 55	265	17 48	21 47
30	8 43	4 8	150	16 16	12 38	270	18 19	22 9
35	10 29	5 52	155	14 57	11 14	275	18 41	22 23
40	12 9	7 33	160	13 31	9 42	280	18 54	22 29
45	13 43	9 9	165	12 1	8 3	285	18 57	22 27
50	15 11	10 39	170	10 26	6 18	290	18 52	22 16
55	16 32	12 2	175	8 48	4 29	295	18 38	21 57
60	17 46	13 19	180	7 6	2 37	300	18 15	21 29
65	18 52	14 28	185	5 19	+ 0 42	305	17 43	20 53
70	19 48	15 30	190	3 29	− 1 15	310	17 1	20 10
75	20 36	16 24	195	+ 1 39	3 11	315	16 10	19 19
80	21 16	17 11	200	− 0 13	5 6	320	15 10	18 21
85	21 48	17 49	205	2 3	6 59	325	14 1	17 15
90	22 11	18 18	210	3 50	8 49	330	12 44	16 2
95	22 26	18 38	215	5 36	10 31	335	11 20	14 43
100	22 32	18 50	220	7 18	12 13	340	9 48	13 17
105	22 30	18 53	225	8 55	13 47	345	8 9	11 46
110	22 19	18 48	230	10 26	15 14	350	6 25	10 9
115	22 1	18 33	235	11 51	16 34	355	4 36	8 28
120	+21 35	+18 9	240	−13 10	−17 46	360	− 2 44	− 6 43

FROM A LETTER OF MR. HIND TO THE EDITOR.

London, 1850, *October* 29.

Signor de Gasparis has been kind enough to send me his symbols for *Hygea* and *Parthenope*, with observations of the new planet. The emblem for *Hygea* is a star and serpent, that for *Parthenope* is a star and fish; both appear to me very appropriate, and easy to write and remember.

In writing to Mr. Bond a few weeks since, I believe I mentioned that the name *Victoria* was submitted to the approbation of astronomers on mythological grounds, and not exclusively as marking the country where the discovery was made. I foresaw the objections you have advanced, and therefore devised a symbol which would apply equally well to *Victoria* or to another name, *Clio*, which I had in view in case the general feeling of astronomers was against the former. ..... I would at once reject any name that is not found in mythology, and I believe that, if Victoria had not been at least a *symbolical* deity of the ancients, the name would not have been so readily adopted in Europe as it has been. However, if American astronomers decidedly object to the name *Victoria* on the ground of precedent, they will greatly oblige me by calling the planet *Clio* with the same symbol, ♅. I presume this name will be free from any objection of the kind you have advanced, and it has the recommendation of being short to write and pronounce, without being liable to be confounded with any of the other small planets. .....

I transcribe here one or two sets of elements of the new planet.

Fearnley used London, September 14, Bonn, September 26, and October 7. H Breen used London, September 14, Greenwich and Cambridge, September 25, and Greenwich and Altona, October 7.

	Fearnley, of Bonn. Epoch 1851, Jan 0, Berlin. Mean Equinox.	Hugh Breen, Royal Obs. Greenwich. Sept. 14.347373, Gr. M. T., Mean Equinox 1850 0.
M	65° 51′ 36″.06	36° 18′ 40″.6
π	301 43 48.55	301 14 59.5
☊	235 48 45.21	235 37 23.7
i	8 19 29.05	8 22 5.9
ϕ	12 42 55.23	12 46 5.6
Log. a	0.3672814	0.3684648

My latest observations are,

	Greenwich M. T. h. m. s.	α h. m. s.	δ ° ′ ″
Oct. 14	8 8 55	23 24 31.73	+8 44 54.4
15	8 23 12	23 24 13.68	+8 34 42.7

Absence from the Observatory has prevented any since the 15th.

J. R. HIND.

ELEMENTS AND EPHEMERIS OF CLIO.

Lieutenant Maury has communicated the following approximate elements and ephemeris of *Clio*, by Mr. Ferguson. The elements are computed from the observations of Sept. 13, 21, and 30.

September 13, Mean Time Greenwich.

M	32° 48′ 29″.2
☊	236 49 43
π	302 55 1.5
i	8 3 38.5
ϕ	14 15 27.4
Log. a	0.3729403
μ	978″.5796

From these elements Mr. Ferguson has computed the following ephemeris, for Greenwich mean noon:—

1850.	⚴ α h. m. s.	⚴ δ ° ′ ″	Log △
Nov. 15	23 31 27	+5 4 11	0.14123
16	23 32 9	5 1 8	0.14507
17	23 32 52	4 58 17	0.14891
18	23 33 37	4 55 42	0.15275
19	23 34 14	4 53 19	0.15659
20	23 35 0	4 51 10	0.16045
21	23 35 46	4 49 15	0.16431
22	23 36 34	4 47 33	0.16811
23	23 37 24	4 46 4	0.17203
24	23 38 16	4 44 49	0.17594
25	23 39 6	4 43 46	0.17985
26	23 39 59	4 42 55	0.18376
27	23 40 53	4 42 19	0.18766
28	23 41 48	+4 41 44	0.19160
Nov. 29	23 42 44	+4 41 39	0.19574
30	23 43 41	4 41 37	0.19968
Dec. 1	23 44 40	4 41 45	0.20343
2	23 45 41	4 42 5	0.20681
3	23 46 43	4 42 37	0.20924
4	23 47 45	4 43 21	0.21371
5	23 48 47	4 44 17	0.21725
6	23 49 50	4 45 25	0.22089
7	23 50 55	4 46 45	0.22453
8	23 52 1	4 48 17	0.22817
9	23 53 6	4 50 1	0.23181
10	23 54 13	4 51 49	0.23559
11	23 55 21	4 53 42	0.23937
12	23 56 29	4 55 47	0.24315
13	23 57 8	+4 58 0	0.24615

The correction to this ephemeris, November 5, was,

α m. s.	δ ′ ″
—1 9	—1 44

Professor Rümker has communicated (October 25) the following elements, computed by Mr. G. Rümker:—

1850, Sept. 13.0, Greenwich Mean Equinox, Sept. 13.

M	35° 45′ 24″.7
π	301 42 56.6
☊	235 32 52.7
i	8 22 45.5
ϕ	12 39 8.5
Log. a	0.3683999

G.

CONTENTS.

THE

ASTRONOMICAL JOURNAL.

No. 20.

VOL. I. CAMBRIDGE, DECEMBER 23, 1850. NO. 20.

ON THE ORBIT OF THE GREAT COMET OF 1843.

BY PROFESSOR J. S. HUBBARD.

(*Continued from page* 60.)

IMMEDIATELY before commencing the solution of the equations of condition, I received from Professor C. PIAZZI SMYTH, through the kindness of Admiral BEAUFORT, a copy of part of the observations made at the Cape of Good Hope. The whole series extended from March 4 to April 13, and the places of the stars of comparison having been subsequently determined by meridian instruments, the observations were completely reduced by Professor SMYTH. The probable importance of this series, both as respects the dates of observation and the geographical advantages of the observer, induced me to delay for a while the final solution of the equations in the hope of obtaining additional weight for the results.

The available observations already received from Professor SMYTH are as follows; the times having been corrected for aberration, and the places for refraction and parallax: —

M. T. Berlin.			C. — O.	No. Obs.	Observer.
March 4.29142	Observed Distance from *Sirius*	94° 23′ 48″.4	—21″.6	15	RUYSCH.
5.28671	" " " *Sirius*	90 47 14.0	—56.0	6	"
5.30036	" " " α *Tauri*	67 6 35.8	—82.4	5	"
5.29021	" α	5 5 42.9	+65.6	2	SMYTH.
5.29021	" δ	—12 1 14.8	+37.9	3	"
9.30408	" α	19 6 25.1	+16.7	4	"
9.31056	" δ	—11 59 41.5	+36.0	7	"

The sextant measures by Mr. RUYSCH agree remarkably well among themselves, and are well entitled to confidence. Several others were taken at the same time by other observers, but I have been able to make no use of them. The right-ascension and declination were observed with a filar-micrometer attached to a Dollond 46-inch achromatic.

The residuals of March 9 were combined with those already given for that date; the remaining five furnished as many new equations. I now solved the whole number, applying the usual control, and obtained

ELEMENTS V.

T	Feb. 27.444827 M. T. Berlin.
π	1° 12′ 23″.58 M. Equinox 1843.0.
ω	82 32 32.59
i	144 18 51.08
Log. q	7.7465865
Log. $(1-e)$	6.0298564

These elements give the residual (C. — O.) for the Portland observation +0″.4; for the Chihuahua altitudes, —37″.4 and +3″.4; and for the three Cape observations of distances, +7″.6, —23″.4, and —31″.9. The sum of the squares of all the residuals is, by $[n\,n_6]$, = 31348″.406, and the probable error of a normal $= \sqrt{\frac{[n\,n_u]}{p-\mu}} = \pm\ 16''.14$. Believing that many of the observations might safely claim greater accuracy, I now attempted a division into classes, and, separating the ring-micrometer observations from the others, obtained the following for the probable error of a single observation: —

	ϱ_α	ϱ_δ
Filar-micrometer	± 13″.83	± 11″.41
Ring-micrometer	± 14.55	± 19.16

This result is in general conformity with theory, which assumes a measured difference in declination as more accurate, and an indirect determination by intervals of transit as less accurate, than an observed difference in right-ascension. It may be remarked, that the true ratios of the errors will probably differ somewhat from the above, since these are but a first approximation, deduced from the erroneous hypothesis of equal

values. I assumed, however, in the following, all the $\varDelta\alpha$ of equal weight, or $hh_a = 1$; the $\varDelta\delta$ determined with the filar-micrometer received the weight $hh_f = [0.16692]$, and the $\varDelta\delta$ determined with the ring-micrometer, the weight $hh_o = [9.76098]$. A normal $\varDelta\delta$ composed of k filar-micrometer and l ring-micrometer observations was assumed $= \frac{hh_f.\Sigma.\Delta\delta_f + hh_o.\Sigma\Delta\delta_o}{k.hh_f + l.hh_o}$, and its weight $= (k.hh_f + l.hh_o)^{\frac{1}{2}}$. For a normal $\varDelta\alpha$ the arithmetical mean of $\varDelta\alpha\cos\delta$ was taken, and its weight $= (k + l)^{\frac{1}{2}}$.

LETTER FROM MR. SCHUBERT TO LIEUTENANT DAVIS.

Cambridge, November 7, 1850.

I HAVE compared lately the declinations of *Sirius*, observed at Greenwich from 1836–1847, with the *Tabulæ Regiomontanæ*, and obtained the following results: —

Year.	Observation.	Tables.	Observ. minus Tables.
1836	—48.73	—49.36	+0.63
1837	53.94	53.91	—0.03
1838	58.19	58.45	+0.26
1839	1.55	3.01	1.46
1840	6.22	7.57	1.35
1841	11.11	12.13	1.02
1842	14.77	16.69	1.92
1843	18.15	21.26	3.11
1844	22.49	25.83	3.34
1845	26.34	30.41	4.07
1846	31.05	34.99	3.94
1847	—35.64	—39.57	+3.93

This rapid increase of the differences seems to denote a period of about eighteen years, whereas that in right-ascension is about fifty years. How is this difference of the periods to be accounted for, if it should prove true after a complete examination of the declinations? This examination is rendered highly important and necessary by the above, and Mr. PETERS will be induced to undertake it, if he has not already begun, since he is especially engaged with *Sirius*. I shall have finished before long the examination of the right-ascension of *α Hydræ*; the results I obtain will be much in favor of my supposition as to the peculiar motion of the fixed stars in space, made in the discussion of *α Virginis*.

The distance of the system of *Sirius* from that of our sun is perhaps not so great as to render impossible the determination of the parallax of *Sirius*, when the knowledge of its peculiar motion in space is completed; a continued comparison with stars in the vicinity will perhaps show it.

E. SCHUBERT.

FROM A LETTER OF PROFESSOR RÜMKER TO THE EDITOR.

Hamburg, 1850, *October* 25.

THE following are among my late observations.

1850.	Hamburg M. T. h. m. s.	⚘ α ° ′ ″	⚘ δ ° ′ ″	
Sept. 3	10 32 5.8	9 9 30.0	—7 26 31.5	
4	9 51 54.0	9 3 2.6	7 34 36.5	
5	9 53 19.7	8 56 7.1	7 43 21.8	
6	13 32 9.6	8 47 22.4	7 53 11.1	Merid.
7	9 54 28.0	8 40 36.3	8 0 30.7	
9	9 48 25.0	8 23 30.7	8 17 47.2	
10	15 42 46.3	8 11 42.9	8 28 47.0	
12	11 58 42.5	7 53 45.7	8 45 4.0	
12	13 5 1.6	7 53 17.7	8 45 25.3	Merid.
15	9 50 2.3	7 22 56.2	9 10 31.2	
17	9 8 0.1	7 0 27.6	9 27 14.2	
18	12 36 58.3	6 46 55.9	9 37 8.0	Merid.
19	12 32 14.5	6 34 55.1	9 45 29.5	"
20	12 27 30.1	6 22 45.5	9 53 44.2	"
25	12 3 37.4	5 19 17.8	—10 32 39.8	"
Sept. 30	11 38 37.6	3 59 0.9	—11 6 50.0	Merid.
Oct. 2	11 30 2.4	3 48 7.3	11 18 48.6	"
6	11 10 57.6	2 57 42.0	11 39 33.7	"
7	11 6 13.0	2 45 29.4	11 44 9.1	"
8	11 1 29.7	2 33 36.6:		
9	10 56 47.3	2 21 57.0	—11 51 53.2	"

Mean places for 1850.0 of certain fixed stars compared with *Flora*, derived from Meridian observation.

✱ α h. m. s.	Ann. Prec. s.	✱ δ ° ′ ″	Ann. Prec. ″
0 27 1.305	+3.045	—9 7 31.0	+19.92
0 28 5.446	3.045	9 2 12.4	19.90
0 28 45.809	3.043	9 16 47.2	19.90
0 29 17.802	3.049	7 23 14.2	19.89
0 32 8.255	3.042	8 49 40.2	19.86
0 32 23.456	3.042	8 41 49.5	19.85
0 32 46.596	+3.042	—8 28 37.0	+19.85

Comet discovered by Mr. Bond.

1850.	M. T. Hamburg. h. m. s.	α ° ′ ″	δ ° ′ ″
Sept. 13	8 53 43.5	104 44 26.0	47 21 48.0
15	10 51 58.6	111 58 59.0	42 50 13.0
17	13 37 22.2	118 39 34.7	37 32 44.2
18	13 43 52.0	121 34 35.1	34 50 48.3
19	13 47 50.0	124 20 35.5	32 3 50.2

[The observations before published are omitted.]

I also inclose a list of mean places for 1850.0 of fixed stars which I have compared with Petersen's third comet, or which have been compared with the same in America.

[This is the list in No. 736 of the *Astr. Nachr.*]

My observations of the new planet are not nearly all reduced. I subjoin some.

1850.	M. T. Hamburg. h. m. s.	α ° ′ ″	δ ° ′ ″	
Sept. 20	10 16 50.6	351 45 18.0	+13 3 4.4	
25	8 23 15.8	353 47 45.3	12 12 25.8	
26	8 39 5.4	353 36 18.3	12 1 43.6	
26	11 12 52.4	353 35 4.8	12 0 35.2	Merid.
28	8 38 3.0	353 14 30.5	+11 39 52.3	
Sept. 29	8 3 26.0	353 4 12.2	+11 29 15.8	
30	9 54 35.7	352 53 3.8	11 17 13.8	
30	10 54 20.3	352 52 38.1	11 16 46.3	Merid.
Oct. 1	7 32 35.5	352 44 7.5	11 7 21.3	
6	10 27 7.0	351 58 15.0	10 10 16.4	Merid.
12	7 33 27.2	351 18 26.8	9 6 21.1	
13	7 10 38.1	351 13 5.3	8 56 8.2	
21	10 32 0.4	350 46 56.2	+7 36 6.2	

Hence my son George Rümker has computed the following elements.

[The elements are already printed upon page 152.]

Computing hence back to the position of the planet May 11, 1835, we obtain nearly the place where Cacciatore observed his supposed planet, but the change of declination is too great. If the planet were then as near its descending node as it actually was to its ascending node, we should make sure of the identity, as its motion in declination would then agree with the observation of Cacciatore.

CHARLES RÜMKER.

NOTE FROM MR. BOND TO THE EDITOR.

Observatory of Harvard College, November 13, 1850.

We have obtained the following positions of the comet of August last since its perihelion passage: —

1850, October 28, 17h. 40m. 11s.

's R.A. 12h. 1m. 40s.66

Dec. —22° 22′ 31″.3

By six comparisons with *β Ceti* by the circles of the great equatorial. The star was observed at each comparison as nearly as possible at the same altitude at which the comet transited. This precaution was necessary in order to avoid the uncertainties of refraction near the horizon, by making the computed corrections of the observed differences of right-ascension and declination very small. The apparent right-ascension and declination of *β Ceti* were taken from the Nautical Almanac.

October 29, 17h. 35m. 13s.

's R.A. 12h. 5m. 53s.67

Dec. —22° 35′ 41″.6

By six differences of right-ascension and four of declination, from a star of the 7th magnitude, H. C. 22971,

*'s R.A. 12h. 8m. 1s.45

Dec. —22° 31′ 5″.4

November 7, 17h. 23m. 30s.

's R.A. 12h. 41m. 44s.50

Dec. —23° 51 9 .0

By four comparisons in right-ascension, and two in declination with a star of the 8 magnitude.

*'s R.A. 12h. 40m. 22s.68

Dec. —23° 58′ 37″.1

The place depends on H. C. 23844 and 23845.

R.A. 12h. 39m. 55s.84 Dec. —24° 1 58 .3

The comet is now fainter than in October.

November 13, 17h. 28m. 5s., M. S. T.

's R.A. 13h. 3m. 10s.94

Dec. —24° 12 54 .0

By six comparisons in right-ascension, and four in declination, with H. C. 24143.

*'s R.A. 13h. 2m. 14s.62

Dec. —24° 13′ 45″.6

By the aid of Mr. Runkle's ephemeris we have obtained the following places of *Parthenope*, depending on the star B. A. C. 6064. They are probably the last which will be obtained during the present apparition.

November 7, 6h. 7m. 31s.

's R.A. 17h. 40m. 57s.51

Dec. —22° 0′ 30 .8

November 9, 5h. 55m. 47s.

's R.A. 17h. 45m. 8s.33

Dec. —22° 4′ 44 .8

It is not brighter than a star of the 12.13 magnitude.

All the above places are referred to the mean equinox of January 1, 1850.

W. C. BOND.

OBSERVATIONS OF THE SECOND COMET OF 1850, MADE AT NEW HAVEN, BY MR. FRANCIS BRADLEY.

[Communicated by Professor HUBBARD.]

THE following observations were made with the filar-micrometer of the ten-foot Dollond telescope belonging to Yale College. The instrument has an unsteady altitude-and-azimuth mounting, very unfavorable to observations of this nature, as the necessity of constant readjustment of the position-circle occasions much loss of time, and the unsteadiness renders the adjustment difficult. The stars of comparison can only be identified by help of an ephemeris and by their configurations. The observations here given have been corrected for refraction only.

Date.	M. T. New Haven.	☄ — * $\Delta\alpha$	☄ — * $\Delta\delta$	No. of Comp. α	No. of Comp. δ	☄'s apparent α	☄'s apparent δ	Comparison-Star.
1850	h. m. s.	m. s.	′ ″			h. m. s.	° ′ ″	
Sept. 3	9 36 37.1	+1 26.56	+ 1 31.73	6	5	4 28 44.06	+57 47 30.24	Diff. from Arg. Z. 68, No. 58.
4	10 18 7.2	—3 39.13	—14 8.58	4	4	4 43 53.68	57 30 57.53	Arg. Zone 68, No. 80.
10	11 39 3.9	+2 5.03	—15 7.20	9	8	6 19 9.52	51 57 16.83	Groombridge 1161 (?).
11	9 39 55.6	—1 42.83	— 0 34.92	7	7	6 32 59.31	+50 32 1.51	Arg. Zone 76, No. 119.

FROM LETTERS OF LIEUTENANT GILLISS TO THE EDITOR.

Santiago de Chile, 1850, *September* 22.

HAD the weather been favorable, I should have obtained observations of PETERSEN's comet last night; but it was entirely overcast, as to-night promises to be also. You may, however, be assured that I will follow it up with the equatorial as long as it may be visible. As you may suppose, my force does not permit the reductions of observations, except such as are absolutely essential to a knowledge of the position of the instruments; seven hours at the meridian-circle on alternate nights being quite as much as Mr. MACREA and myself can risk with our eyes. An appeal has been made to the department for more aid, but in vain; and it is greatly to be feared a zone must be left unexplored between our observations and those which the Washington Observatory can advantageously make. This is of the more consequence from the multitude of errors that have crept into the observations or reductions of LACAILLE's Zones, and the number of double stars which escaped even that keen observer Sir JOHN HERSCHEL, on the expedition specially undertaken for their search. ..... I earnestly hope that I may yet be allowed another assistant or two, in order that the meridian-circle may be used all night. Under existing circumstances, the equatorial has necessarily been unoccupied since the series of differentials with *Mars*, except for an occasional occultation. ..... The series on the planet *Venus* will be commenced next month, and as clouds are unknown here from October to May, we may expect no interruption from this cause. Unfortunately, the past winter has been more obscure than any remembered since 1827, and our work has not made the progress our impatience desired; — yet I find we had ten nights of observations in June, with eight nights for zones, embracing 444 observations; in July, sixteen nights with nine zones, in all numbering 528 observations; and in August twenty nights with ten zones, comprising 576 observations. There are not much short of five thousand stars in all, since the commencement of work, about the middle of February last; and it is probable the number will be increased to twenty thousand during the ensuing season. ..... In a recent letter to Professor J. H. C. COFFIN, I sent a list of errors in the catalogues of the British Association and LACAILLE, which he has probably communicated to you.* As soon as the new assistant arrives, you shall be furnished with such observations as are of more immediate interest in perfecting the ephemerides of the new planets, — to which as much time will be given as the objects laid down in the programme of our work will possibly permit. .....

Subjoined, I send you the only planetary observations (except of the moon) which we have made; they are of the body to whose orbit our friend WALKER has devoted so much labor, and with such distinguished success. The meridian-circle with which they were made is of somewhat more than three feet diameter, and constructed by PISTOR and MARTINS at Berlin. Both circles are divided to 2′, and are read by two micrometer microscopes each to 0″.5, — the latter being supported on horizontal bearers. Its telescope is fifty-one lines aperture, and in

* Professor COFFIN informs me that the letter referred to has never reached him. G.

this atmosphere is of wonderful optical capacity, enabling us to distinguish objects which Sir John Herschel lost sight of, — and with a power of ninety-six readily separating stars which he puts down at $\frac{3}{4}''$ to $1''$ distant. At the observation on the 19th there was an elongation or an object very close following, which was not seen previously; but the night was not wholly free from very thin cirri, and the transit over the meridian did not permit as long examination as was essential to determine its nature. The latitude adopted in the reductions is —33° 26′ 23″, and the longitude computed from three occultations and five moon-culminations is $4^{h.}$ $44^{m.}$ 19^{s} west of Greenwich.

1850, *October* 29.

There were several cloudy nights after the receipt of the ephemerides sent by you, and when I could look for the comet of Petersen, I failed to find it, after a very thorough sweep. ..... The captain of a French vessel recently arrived from Conception, states that on the nights of the 18th and 19th September, about midnight, he saw a cometary body in the northwest, and that when he brought his sextant on shore on the third night to measure it, the object was not to be discovered. It was near the horizon when seen on the preceding occasions, and, as he says, quite bright.

Although we had cloudy weather about that time, the nights of the 18th and 20th were fine, and I am sure no such object could have escaped the attention of both Mr. Macrea and myself, descending from Santa Lucia, as we do between midnight and 1 A. M.

I have sent to Mr. Walker meridian observations of *Venus* (unreduced), and *α Scorpii* and *α Tri. Australis* from the 19th to the 26th inclusive, together with the differential measures of the 25th, in the hope that some one may have corresponding observations in the northern hemisphere.

I find an error of $2^{m.}$ in the place of the comparison-star for the 25th and 26th inst., it being much too small as given me at the Washington Observatory.

Meridian observations of *Neptune*, made by the U. S. N. Astronomical Expedition.

Date 1850.	Ψ α h. m. s.	Ψ δ ° ′ ″	Weight.
Sept. 9	22 29 43.805	—10 18 35.4	10
10	29 38.199	19 7.2	8
18	28 51.340	23 43.8	8
19	28 45.596	24 17.9	10
Oct. 10	27 0.873	34 17.9	8
14	26 41.983	35 48.6	9
18	26 31.000	37 8.7	7
22	22 26 18.220	—10 38 19.9	9

Assumed longitude, $4^{h.}$ $42^{m.}$ $23^{s.}$ West.
" latitude, 33° 26′ 23″ South.

J. M. GILLISS.

FROM A LETTER OF MR. FAYE TO THE EDITOR.

Observatory of Paris, 1850, *November* 15.

A point to which I wish to call your attention relates to the total eclipse of July next, which is visible I think over a large part of your immense territory. You know how much attention was everywhere given to that of 1842, and the mysterious appearances which struck the observers so forcibly. The question is now to discover whether that of 1851 will finally give us the solution of these singular problems, and if we must decidedly believe their source to be in the solar atmosphere, in red clouds which float suspended in it, in planetary clouds, &c., — or if we are to see in these appearances but the ordinary phenomena of mirage, produced on a grand scale in our atmosphere by the cooling of long, oblique, and concentric strata, as the penumbra and lunar shadow pass over it.

As for myself, I am persuaded that the brilliant halo, — the *glory* which surrounds the moon during the total obscuration, — is nothing else than the excessively rare atmosphere of the moon, rendered visible by the sun's rays. I believe that the phenomena of conical mirage will account for the luminous beams [*aigrettes*] seen by many observers, — for the expansion of the halo, — for the two concentric images, whether in contact or not, — for the roseate mountains which were seen so distinctly in 1842, — and also for the interior light noticed by Ulloa and by Valz; these mountains and these luminous fissures being simply the images of brilliant points of the lunar surface, seen through certain valleys whose position happens to allow, and the form of which has been enlarged and distorted by the passage of the rays of light through strata of different densities. I suppose that these strata are situated parallel to the sides of the conical shadow, and that they appear differently to different observers, according to their position in this cone.

I have expressed this opinion in one of the late meetings of the Academy of Sciences, and propose to develop it, with all the arguments in its support, as soon as I shall have the time. If it appear to you admissible, you will doubtless judge as I do, that it is not with ordinary physical apparatus that this eclipse can be studied to the best advantage; but with captive balloons, or better still with aërostats, where observers can measure the variations of temperature at the greatest possible

height. The calculations which I have made thus far, in order to follow the course of the rays through the strata of our atmosphere, require a series of hypotheses concerning these variations of temperature; and although the hypotheses which I have made appear to me plausible, it is evident that nothing can be so reliable as the direct measurements.

Permit me also to recommend, for the observation of this eclipse, the employment of portable equatorial stands for your telescopes, and, above all, the attainment if possible of photographic impressions of different phases of the phenomenon.

H. FAYE.

ELEMENTS OF CLIO.

Mr. T. H. Safford has computed elements of *Clio* from observations at London, September 13 and October 15, and Cambridge, November 25.

Epoch 1850, October 15.0, M. T. Greenwich.

M	$41^\circ 27' 32''.8$
Ω	235 30 26.0
i	8 22 51.9
ω	66 37 4.3
ϕ	12 32 4.5
Log. a	0.3679504
μ	$995''.5909$
Period	1302 days.

NEW PLANET.

Mr. de Gasparis discovered in Naples, November 2, a new planet, resembling a star of the 9.10 magnitude.

Professor Schumacher announces the discovery in a circular dated November 14, and states that Mr. de Gasparis found the planet by means of the Zones in the vicinity of the ecliptic, which he had constructed to aid him in his search for planets.

The observations are,

At Naples, by Mr. de Gasparis:

1850.	M. T. Naples. h. m. s.	α	δ
Nov. 2	7 3 6.5	$30^\circ 31' 49''.9$	$+7^\circ 58' 55''.0$
3	7 21 41.4	30 14 58.3	+8 0 18.5

At Altona, by Dr. Petersen:

1850.	M. T. Altona. h. m. s.	α	δ
Nov. 13	13 25 45.2	$27^\circ 34' 25''.0$	$+8^\circ 19' 38''.6$

Dr. Petersen estimates it as of the 10 magnitude.

G.

Cambridge, 1850, *December* 6.

CONTINUATION OF THE INVESTIGATION OF CHANGE OF PLACE IN THE FIXED STARS.

By ERNEST SCHUBERT.

[Communicated by Lieutenant Davis, Superintendent of the Nautical Almanac.]

I have mentioned at the conclusion of my paper on the right-ascension of α *Virginis*, that I had been led to the supposition, that changes, other than those already known, occur in the places of the fixed stars. I mean probable motions around the common centers of gravity of the systems of which they are the parts visible to us, provided, however, that the systems are not at too great a distance, and that these motions are of sufficient extent. I had considered, therefore, the results for α *Virginis* as merely relative to the stars of comparison, for which reason I did not attempt to determine an orbit in space, but contented myself merely with the relative period.

A liberal allowance of time having been granted me by Lieutenant Davis, Superintendent of the Nautical Almanac, I undertook the comparison of α *Hydræ* in right-ascension with α

Orionis, *β Orionis*, and *α Canis minoris*. The latter star was, however, afterwards excluded from among the comparison-stars, in order to compare it also with the two others. It is this star whose variation in declination has been already shown to be probable by BESSEL.

TABLE I.

α Hydræ compared with *α* and *β Orionis*.

	1767.	1768.	1771.	1773.	1774.	1776.	1777.	1778.	1779.	1781.
	s.	s.	s.	s.	s.	s.	s.	s.	s	s
	—0.011	—0.075	—0.232	—0.090	—0.183	—0.355	—0.243	—0.077	+0.035	—0.145
	—0.013	—0.072	+0.016	+0.003	—0.153	+0.062	—0.163	—0.034	—0.154	—0.065
	—0.039	—0.128	—0.090	—0.032	—0.012	—0.146	—0.036	—0.002	—0.151	—0.268
	+0.015	—0.082	+0.006	—0.055	—0.095	—0.074	+0.049	—0.089	—0.070	—0.281
	—0.114	—0.093	+0.094	—0.097	—0.260	—0.191	—0.014	—0.078	—0.003	—0.036
	—0.086	—0.102	—0.108	—0.239	—0.022	—0.226	—0.130	—0.064	—0.089	—0.042
	+0.018		—0.039	—0.077	+0.018	—0.046	—0.038	(+0.061)	—0.107	—0.144
	—0.046		—0.158	—0.253	—0.180	+0.008	+0.083		—0.006	—0.064
	—0.049		—0.019	—0.069	—0.083		—0.016			—0.015
				—0.054	—0.294		—0.104			+0.047
				—0.299	+0.088					
				—0.313						
Mean	—0.036	—0.092	—0.059	—0.131	—0.107	—0.121	—0.061	—0.057	—0.068	—0.101
No. of Obs.	9	6	9	12	11	8	10	6	8	10

	1782.	1783.	1784.	1785.	1786.	1787.	1788.	1789.	1790.	1791.
	s.	s.	s.	s	s.	s.	s.	s.	s	s.
	—0.238	—0.063	—0.159	—0.276	—0.098	—0.242	—0.021	—0.031	—0.038	+0.018
	—0.091	—0.134	—0.174	—0.272	—0.361	—0.198	—0.160	—0.303	+0.038	—0.090
	—0.131	—0.080	—0.080	—0.250	—0.076	—0.156	+0.017	—0.251	—0.001	—0.036
	—0.099	+0.013	—0.133	—0.182	—0.035	—0.152	—0.256	—0.232	—0.092	+0.078
	—0.104	—0.149	—0.147	—0.097	+0.080	—0.251	—0.171	+0.036	—0.161	—0.112
	—0.164	—0.035	—0.165	(+0.073)	—0.217	—0.005	+0.012	—0.062	—0.115	—0.129
	—0.203	+0.024	—0.082	—0.065	—0.085	—0.010	—0.006	+0.076	—0.261	—0.043
	+0.050	—0.078		—0.248	—0.137	—0.006	—0.023	—0.015	—0.010	—0.100
	—0.023	—0.147		—0.054	—0.198		—0.140	—0.080	—0.095	(+0.140)
	+0.005	—0.087					+0.016	+0.015	+0.196	
	(—0.331)	—0.035						+0.134	+0.071	
		+0.012								
Mean	—0.100	—0.063	—0.133	—0.180	—0.125	—0.128	—0.073	—0.065	—0.043	—0.052
No. of Obs.	10	12	7	8	9	8	10	11	11	8

	1792.	1793.	1794.	1795.	1796.	1798.	1800.	1801.	1802.	1811.
	s.	s.	s.	s.	s	s.	s.	s.	s.	s
	—0.277	—0.115	—0.193	—0.155	—0.362	—0.213	—0.085	—0.238	—0.191	—0.366
	+0.046	—0.048	—0.121	—0.108	—0.032	—0.174	—0.080	—0.110	—0.322	—0.168
	+0.005	—0.048	—0.184	—0.116	+0.002	—0.077	—0.120	—0.159	—0.082	—0.296
	—0.122	—0.112	—0.210	—0.217	—0.116	—0.126	—0.200	—0.071	+0.091	—0.141
	—0.238	—0.163	—0.215	—0.091	—0.418	—0.143	—0.284	—0.062	—0.098	—0.133
	—0 025	—0.106	—0.175	—0.164	—0.386	—0.157	+0.106	—0.056	+0.165	—0.100
	—0.045	—0.139	—0.238	—0.082	—0.306	—0.219	—0.122	—0.134	+0.017	+0.087
	—0.123	—0.086	+0.068	—0.105	—0.177		+0.056	—0.093		+0.196
		(+0.092)	—0.153	—0.025	—0.157			+0.024		
		—0.063	—0.191		+0.121			+0.098		
					—0.310					
					+0.126					
Mean	—0.097	—0.098	—0.161	—0.122	—0.168	—0 158	—0.102	—0.080	—0.060	—0.115
No. of Obs.	8	9	10	9	12	7	8	10	7	8

Year.	Observation minus Tables. β *Orionis.*	Observation minus Tables. α *Orionis.*	Mean.	α *Hydræ* Obs. minus Tab. = D.	D minus Mean.	Year.	Observation minus Tables. β *Orionis.*	Observation minus Tables. α *Orionis.*	Mean.	α *Hydræ.* Obs. minus Tab. = D.	D minus Mean.
	s.	s.	s	s.	s.		s.	s.	s.	s.	s.
1829.0	+0.263	+0.021	+0.142	+0.182	+0.040	1839.0	+0.088	+0.045	+0.066	+0.100	+0.034
1830.0	+0.132	+0.054	+0.093	+0.139	+0.046	1840.0	+0.109	+0.109	+0.109	+0.094	—0.015
1831.0	+0.176	+0.081	+0.128	+0.164	+0 036	1841.0	+0.087	—0.006	+0.041	+0.106	+0.065
1832.0	+0.169	+0.091	+0.130	+0.150	+0.020	1842.0	+0.098	+0.063	+0.081	+0.152	+0.071
1833.0	+0.094	+0.075	+0.085	+0.143	+0.058	1843.0	+0.056	—0.066	—0.005	+0.058	+0.063
1834.0	+0.064	+0.082	+0.072	+0.184	+0.112	1844.0	—0.029	—0 006	—0.018	+0.081	+0.099
1835.0	+0.030	+0.105	+0.068	+0.123	+0.055	1845.0	—0.038	—0.045	—0.042	+0.063	+0.105
1836.0	+0.060	+0.072	+0.066	+0.155	+0.089	1846.0	+0.038	+0.014	+0.026	+0.101	+0.075
1837.0	+0.088	+0.089	+0.089	+0.118	+0.029	1847.0	+0.014	—0.057	—0.022	0.000	+0.022
1838.0	+0.058	+0.073	+0.066	+0.091	+0.025						

I subjoin now a table of the means in the form of equations of condition, in which x denotes the probable correction of the right-ascension for 1755, and y the probable correction of the proper motion, for obtaining x and y by the method of the least squares, — of course relatively to the stars of comparison, although we may conclude, *a priori*, that the periods indicated by the differences are not to be explained by that correction proportional to the time.

The differences obtained by the comparisons show variations included in short periods. The maxima in 1785 and 1796 indicate a probable period of eleven years, so that accordingly maxima have occurred

About	And minima about
1763	
	1769
1774	
	1780
1785	
	1791
1796	
	1802
1807	
	1813
1818	
	1824
1829	
	1835
1840	
	1846

This agrees in a remarkable manner with the differences of Table II. In the comparisons of the more modern observations, the sign of the differences is changed, which is explained by an error in the proper motion ; so that the minima of the positive differences by the modern observations correspond to the maxima of the negative differences by the earlier observations, and the maxima of the positive differences to the minima of the negative.

(*Continued on the next page.*)

CORRIGENDA.

Page 87, col. 2, line 7, *for* May 28, *read* May 29.
" 144, in equation VIII., *for* β^{2s-1}, *read* β^{2s+1}.

CONTENTS.

THE

ASTRONOMICAL JOURNAL.

No. 21.

VOL. I. CAMBRIDGE, JANUARY 18, 1851. NO. 21.

CONTINUATION OF THE INVESTIGATION OF CHANGE OF PLACE IN THE FIXED STARS.

By ERNEST SCHUBERT.

[Communicated by Lieutenant DAVIS, Superintendent of the Nautical Almanac.]

(*Continued from page* 160.)

TABLE II.

EQUATIONS OF CONDITION.

Year.		Observ.	Calc.	Calc. — Obs.	Year.		Observ.	Calc.	Calc. — Obs.
		s.	s.	s.			s.	s.	s.
1767.2	$x + 12.2\,y =$	—0.036	—0.140	—0.104	. . .				
1768.2	$x + 13.2\,y =$	—0.092	—0.138	—0.046	1798.2	$x + 43.2\,y =$	—0.158	—0.061	+0.097
. . .					. . .				
. . .					1800.2	$x + 45.2\,y =$	—0.102	—0.056	+0.046
1771.2	$x + 16.2\,y =$	—0.059	—0.130	—0.071	1801.2	$x + 46.2\,y =$	—0.080	—0.053	+0.027
. . .					1802.2	$x + 47.2\,y =$	—0.060	—0.051	+0.009
1773.2	$x + 18.2\,y =$	—0.131	—0.125	+0.006	. . .				
1774.2	$x + 19.2\,y =$	—0.107	—0.122	—0.015	. . .				
. . .					1811.2	$x + 56.2\,y =$	—0.115	—0.028	+0.087
1776.2	$x + 21.2\,y =$	—0.121	—0.117	+0.004	. . .				
1777.2	$x + 22.2\,y =$	—0.061	—0.115	—0.054	. . .				
1778.2	$x + 23.2\,y =$	—0.057	—0.112	—0.055	1829.0	$x + 74.0\,y =$	+0.040	+0.018	—0.022
1779.2	$x + 24.2\,y =$	—0.068	—0.110	—0.042	1830.0	$x + 75.0\,y =$	+0.046	+0.021	—0.025
. . .					1831.0	$x + 76.0\,y =$	+0.036	+0.024	—0.011
1781.2	$x + 26.2\,y =$	—0.101	—0.104	—0.003	1832.0	$x + 77.0\,y =$	+0.020	+0.026	+0.006
1782.2	$x + 27.2\,y =$	—0.100	—0.102	—0.002	1833.0	$x + 78.0\,y =$	+0.058	+0.029	—0.029
1783.2	$x + 28.2\,y =$	—0.063	—0.099	—0.036	1834.0	$x + 79.0\,y =$	+0.112	+0.031	—0.081
1784.2	$x + 29.2\,y =$	—0.133	—0.097	+0.036	1835.0	$x + 80.0\,y =$	+0.055	+0.034	—0.021
1785.2	$x + 30.2\,y =$	—0.180	—0.094	+0.086	1836.0	$x + 81.0\,y =$	+0.089	+0.036	—0.053
1786.2	$x + 31.2\,y =$	—0.125	—0.092	+0.033	1837.0	$x + 82.0\,y =$	+0.029	+0.039	+0.010
1787.2	$x + 32.2\,y =$	—0.128	—0.089	+0.039	1838.0	$x + 83.0\,y =$	+0.025	+0.042	+0.017
1788.2	$x + 33.2\,y =$	—0.073	—0.087	—0.014	1839.0	$x + 84.0\,y =$	+0.034	+0.044	+0.010
1789.2	$x + 34.2\,y =$	—0.065	—0.084	—0.019	1840.0	$x + 85.0\,y =$	—0.015	+0.047	+0.062
1790.2	$x + 35.2\,y =$	—0.043	—0.081	—0.038	1841.0	$x + 86.0\,y =$	+0.065	+0.049	—0.016
1791.2	$x + 36.2\,y =$	—0.052	—0.079	—0.027	1842.0	$x + 87.0\,y =$	+0.071	+0.052	—0.019
1792.2	$x + 37.2\,y =$	—0.097	—0.076	+0.021	1843.0	$x + 88.0\,y =$	+0.063	+0.054	—0.009
1793.2	$x + 38.2\,y =$	—0.098	—0.074	+0.024	1844.0	$x + 89.0\,y =$	+0.099	+0.057	—0.042
1794.2	$x + 39.2\,y =$	—0.161	—0.071	+0.090	1845.0	$x + 90.0\,y =$	+0.105	+0.059	—0.046
1795.2	$x + 40.2\,y =$	—0.122	—0.069	+0.053	1846.0	$x + 91.0\,y =$	+0.075	+0.062	—0.011
1796.2	$x + 41.2\,y =$	—0.168	—0.066	+0.102	1847.0	$x + 92.0\,y =$	+0.022	+0.064	+0.042

From this we have,

$$49\,x + 2524\,y = -1^s.927$$
$$2524\,x + 164753\,y = -10^s.259$$

And

$$x = -0^s.171$$
$$y = +0^s.002559$$

The errors remaining after the application of the method of the least squares (Calc. — Obs.) in the above Table II. still clearly show by their signs the existence of a period. The comparisons of the modern observations of *β Orionis* with the *Tabulæ Regiomontanæ* also indicate by the differences the probable existence of a periodical variation, as may be seen in Table I., which compels us to regard the periods obtained for the stars compared only as relative. *β Orionis* is a double star, therefore a visible part of a system. *α Hydræ* is, according to Sir J. Herschel, variable in light. May there not be a relation? As is well known, the variations in light of many stars have been explained by some astronomers by the motions of bodies invisible to us around those stars.

I give now the mean results of the comparisons of *α Canis minoris* with *α* and *β Orionis*. The comparisons of two or three successive years are united in one mean, which is here authorized by the fact, that the variation is included in a much longer period than in the case of *α Hydræ*.

Years,	1766 to 1768	1771 and 1773	1774 and 1776	1777 to 1780	1781 to 1783	1785 to 1787	1788 to 1790	1791 to 1793	1794 to 1796	1800 to 1802	1811
Numb. Obs. comp.	17	17	15	17	22	25	29	22	25	23	6
Mean,	s. +0.067	s. +0.032	s. +0.014	s. —0.019	s. —0.038	s. —0.071	s. —0.088	s. —0.160	s. —0.175	s. —0.149	s. —0.035

The results for *α Hydræ* and *α Canis minoris* are accordingly entirely different from each other, just as both are different from the result obtained for *α Virginis*. It is true, that in the latter result *α Canis minoris* has been used with *α* and *β Orionis* as a star of comparison; it was, however, seldom used for that purpose in the years of its greatest deviations, so that in the means with *α* and *β Orionis* its variations can have affected the result for *α Virginis* but very slightly. This diversity in the character of the results proves, therefore, clearly, that the variations do not belong only to one or both stars of comparison, in which case the results for all the stars compared would have necessarily the same character, but that they exist also in the stars compared, themselves.

Those changes of place, the existence of which has been put by these investigations beyond all doubt for *α Canis majoris*, *α Canis minoris*, *α Virginis*, *α Hydræ*, and most probably also for *β Orionis*, are not to be explained by the causes already known, but they are, in all probability, nay certainty, the motions in the system of which such a star is a part visible to us.

The constitution of many of the systems to which the fixed stars belong is most probably different from that of our solar system. In the latter, the sun is so vastly disproportionate in mass to the other parts of the system individually, and even to the sum of all taken together, that the common center of gravity always lies near the center of the sun, and the same is true of the systems of the planets which have satellites. This is the reason why we are authorized in our solar system, to determine the orbit of a body, as if that and the central body were the only ones existing, and we are then obliged to take the other bodies into consideration merely as disturbing bodies, by means of "the problem of the three bodies," treated as the theory of perturbation. If, however, several powerful bodies, not so diverse in mass, are combined together in a system, then the "problem of the three bodies" is to be applied in its most general sense.

The moons in our solar system, as attendants of the planets, are extremely dependent upon their central bodies, and each one is compelled to revolve around its primary without being itself allowed a particular motion around its axis (its self); they are the slaves of the more powerful in the system of the sun. The planets now are somewhat more independent, and the more so as the distance from the sun is greater at which they have taken their position, which becomes apparent by the more rapid rotation round their axes, and by the circumstance, that they form with satellites smaller systems within the system. With the increase of the distance from the sun is also the increase of the capacity of emitting light of their own most probable. *Neptune* would hardly be so bright if he only reflected the light of the sun. There is nothing now to prevent us from combining in a system several powerful bodies with a sun visible to us, to which they themselves, however, are greatly inferior in intensity of light, and in whose splendor they are lost for us. In such a system, all the bodies, even the visible sun, can have motions round the common center of gravity of such extent, that we become sensible of them, as we have seen in the case of the above stars, while at the same time the motion of the whole system, the so-called proper motion, may be comparatively slow. If we continue in this manner to combine together celestial bodies in systems, we arrive at the case in which suns form a system with each other, of which the double, triple, &c. stars furnish examples. But still farther, we can have then double systems where two systems are united to form one of a still higher order, an instance of which we probably have in *ε* and 5 *Lyræ*.

Since it is probable that the brighter stars are nearer our solar system than those of less magnitude, so that we can perceive the motions in the systems of the first only, in which the instances, at any rate, may be more numerous, it becomes now the business of observers to determine approximately the absolute periods of those stars of which such a motion is ascertained, and that by comparison with smaller stars in their vicinity. It will, perhaps, even become necessary to determine

accurately the places of smaller stars instead of the fundamental stars now in use, until, after the lapse of centuries, astronomy shall have so determined the periods of the brighter stars, that they can be taken into account in the computation of their places.

Cambridge, 1850, *Dec.* 6.

FROM A LETTER OF PROFESSOR GOLDSCHMIDT TO THE EDITOR.

Göttingen, 1850, *November* 24.

Of the newest, as yet nameless planet of Gasparis, we have thus far only the two Neapolitan observations, and Dr. Petersen's of November 13. A circular orbit, computed from the observations of November 2 and November 13, gives

Epoch November 13.56914 M. T. Berlin.

i	15° 36′ 5″.4
☊	43 46 57.2
Log. a	0.3935000
μ	911″.50
Mean Long.	37° 14′ 17″.9

The two observations on which this orbit is based are represented within a few tenths of a second of arc. For the observation of November 3 we have

Observation,	$\lambda = 30°\ 57'\ 16''.4$	$\beta = -4°\ 3'\ 40''.8$
Calculation,	30 57 10.9	—4 3 33.8

These differences of —6″.5 and +7″.0 might be easily divided between the first and second observations, but I hope soon to have materials for computing an elliptic orbit. We have not been able to look for this planet here, as we have had no clear evening since the news of its discovery reached us. Moreover, the planet is, according to Dr. Petersen, exceedingly faint, and very possibly will not be observable with the meridian-circle, as it is receding rapidly from the earth. The above elements give for the log. of the distance from the earth,

1850.	Log. Δ
Nov. 2.29145	0.1736626
13.56914	0.1857346
20.5	0.1975455
Dec. 2.5	0.2239127
14.5	0.2550549

Professor Gauss remarked to me lately how very desirable it is that some astronomer, possessing the necessary means, should apply himself in earnest to determining the relative brightness of the new planets, whose number already amounts to thirteen. The relative brightness of *Ceres*, *Pallas*, *Juno*, and *Vesta*, we already know tolerably well. *Vesta* is doubtless the brightest of all, then follow *Ceres*, *Juno*, *Pallas*; although *Pallas*, when in opposition and perihelion at the same time, can appear as bright as *Juno*, or even brighter. Gauss considers that it would be best to place two telescopes, of power as nearly equal as possible, side by side, and directed to two different asteroids, then, quickly moving the eye from one to the other, to judge which of the respective planets is the brighter, without any farther attempt to estimate the ratio. Then, changing the telescopes, the observation should be repeated, and so on. Steinheil's photometer would hardly suffice for objects so faint as the small planets.

B. GOLDSCHMIDT.

FROM A LETTER OF MR. GRAHAM TO THE EDITOR.

Markree Observatory, *Collooney*, *Ireland*, 1850, *December* 17.

From two very accurate places of *Metis*, 1848, May 15, and 1849, August 31.5, and a meridian observation made here the 11th instant, I have obtained a new set of elements, which, it is hoped, do not differ much from the truth. The results are,

Metis.

Instantaneous ellipse for

Epoch 1848, May 0.0 Greenwich M. T.

M	144° 19′ 41″.25
π — ☊	2 33 21.33
☊	68 27 46.76
i	5 35 48 03
φ	7 3 27.32
μ	962″.6884

These are based on

G. M. T.	λ	β
1848, May 15.0	220° 37′ 11″.17	+3° 26′ 7.805
1849, Aug. 31.5	327 9 39.75	—9 29 37.54
1850, Dec. 11 70619	145 8 43.65	+6 8 9.11

referred to the mean equinox of the respective dates.

The residual differences are

Obs — Calc.

$\Delta\lambda$	$\Delta\beta$
—0″.29	+0″.03
—0 10	+0.04
—0.39	0.00

The perturbations by the *Earth*, *Mars*, *Jupiter*, and *Saturn*

have been taken into account. If I can get an ephemeris prepared in good time, I will send a copy. Meanwhile, the following small table may save some trouble to your astronomers.

Effect of Perturbations on the Elements.

Date.	δL	$\delta \Pi$	$\delta \Omega$	δi	$\delta \varphi$	$\delta \mu$
From 1848, May 0.0 to 1850, Dec. 16	—211.07″	+145.40″	—41.57″	—1.984″	—120.45″	—0.0607″
1851, Jan. 5	191.39	170.30	42.09	2.018	120.38	0.0773
" 25	165.86	200.26	42.90	2.057	120.16	0.0996
Feb. 14	134.03	235.74	44.06	2.099	119.78	0.1279
March 6	95.69	277 04	45.60	2.139	119.25	0.1625
" 26	50.99	324.24	47.58	2.169	118.57	0.2032
April 15	—0.20	+377.43	—50.07	—2.183	—117.78	—0.2499

A. GRAHAM.

OBSERVATIONS OF HYGEA.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

BY MR. JAMES FERGUSON.

Communicated by Lieutenant MAURY, Director of the Observatory.

[Corrected for refraction.]

Date.		M. T. Washington.	No. of Comp.	Comparison-Star.	⚕ — * $\Delta\alpha$	⚕ — * $\Delta\delta$	⚕'s apparent α	⚕'s apparent δ	A.*
	1850.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
	May 18	14 49 34.8	2	*a*	+1 21.76	+25 2.97	19 44 48.61	—22 9 47.33	9
	20	14 5 1.6	4	*c*	—0 52.26	— 0 47.06	44 50.78	8 14.74	8
		14 36 37.6	3	"	—0 51.76	— 0 42.15	44 51.27	8 9.97	8
	21	14 22 2.0	5	*e*	—2 12.30	+13 53.66	44 49.37	7 28.07	10
(1)	23	13 6 21.6	2	"	—2 19.80	+15 11.44	44 42.02	6 10.12	9
			2	*c*	—1 0.85	+ 1 20.48	44 42.38	6 7.87	9
	26	12 46 22.6	10	"	—1 23.24	+ 2 56.96	44 20.04	4 30.27	10
			10	*e*	—2 42.10	+16 50.44	44 20.23	4 30.88	10
	27	12 37 56.3	8	*c*	—1 33.79	+ 3 22.74	44 9.58	4 4.46	8
			8	*e*	—2 52.80	+17 17.01	44 9.44	4 4.31	8
	June 4	12 20 51.7	1	Lal. 37507	+4 14.77	— 9 18.51	41 53.36	1 57.44	8
	10	12 57 51.5	2	"	+1 32.97	— 9 37.01	39 11.69	2 15.63	10
	11	12 2 34.1	16	"	+1 2.87	— 9 48.20	38 41.55	2 26.74	9
	12	12 19 6.2	10	"	+0 29.64	— 9 59.69	38 8.44	2 38.15	9
	13	12 4 29.0	10	"	—0 3.78	—10 14.51	37 35.03	2 51.02	8
	24	12 49 37.1	10	Lal. 37221	—0 51.62	+16 33.88	19 30 10.40	7 6.74	9
	Aug. 2	11 12 4.4	3	B. A. C. 6507	+3 45.58	—19 19.62	18 59 29.80	16 26.51	8
	7	10 58 18.9	14	"	+0 59.68	—18 30.29	56 43.94	15 36.49	8
	9	10 51 44.3	14	"	+0 2.56	—17 52.68	55 46.81	14 59.74	8
	11	11 19 12.9	12	"	—0 49.90	—17 3.85	54 54.32	14 10.94	9
	12	10 51 43.5	10	"	—1 13.62	—16 42.78	54 30.61	13 49.92	9
	15	10 29 26.2	5	"	—2 16.87	—15 21.22	53 27.34	12 29.44	9
	16	10 33 23.0	8	"	—2 35.41	—14 51.70	53 8.79	11 58.95	10
(2)	26	9 30 3.7	2	*f*	—0 47.11	— 3 26.26	51 24.48	6 2.02	10
	27	9 51 21.0	10	"	—0 49.74	— 2 45.00	51 21.85	5 20.87	9
	28	9 40 16.6	16	*g*	+0 41.33	— 3 17.54	51 20.65	4 38.94	9
	29	8 51 23.9	14	"	+0 41.64	— 2 36.46	51 20.95	3 57.91	10
	31	9 51 3.8	10	"	+0 46.56	— 1 0.62	18 51 25.84	—22 2 22.14	7

* The column A. indicates the condition of the atmosphere, 10 being the most favorable.

(1) The observations up to the 26th May have been already published.

(2) From this date, August 26, till the termination of the series, there were many small stars about the path of the planet, making it necessary to observe more than one star. Occasionally the wrong star was observed, and the observation lost.

Date. 1850.	M. T. Washington. h m. s.	No. of Comp.	Comparison-Star.	⯚ — * Δα m s.	⯚ — * Δδ ′ ″	⯚'s apparent α h. m. s	⯚'s apparent δ ° ′ ″	A.
Sept. 2	9 25 46.7	12	*g*	+0 57.27	+ 0 34.46	18 51 36.52	—22 0 47.11	7
3	9 28 18.4	10	"	+1 4.78	+ 1 24.56	51 44.02	—21 59 57.04	10
4	8 58 44.9	5	"	+1 13.49	+ 2 13.67	51 52.62	59 7.96	8
6	9 24 44.9	7	"	+1 35.24	+ 4 0.42	52 14.44	57 21.28	7
10	9 58 46.2	7	B. A. C. 6507	—2 28.35	+ 3 28.28	53 15.55	53 39.78	8
11	8 7 56.9	6	"	—2 11.11	+ 4 22.53	53 32.51	52 48.43	10
12	8 46 2.7	10	"	—1 50 90	+ 5 25.09	53 53.00	51 43.05	10
13	8 39 17.6	10	"	—1 29 86	+ 6 25.27	54 13.98	50 42.89	10
16	8 58 0.9	10	"	—0 18.07	+ 9 40.61	55 25.73	47 27.65	8
	9 55 18.9	5	"	—0 17.27	+ 9 43.65	55 26.53	47 24.62	8
17	8 8 21.8	13	"	+0 6.77	+10 47.38	55 50.55	46 20.97	8
(1) 20	8 57 41.3	1	"	+1 33.69	+14 34.10	57 17.41	42 35.28	8
21	8 39 35.3	2	"	+2 4.60	+15 34.76	57 48.62	41 33.65	10
	8 52 34.1	7	*i*	—0 17.66	— 2 44.02	57 48.52	41 34.56	
22	8 1 22.4	10	"	—0 13.38	— 1 33.02	58 19.54	40 23.58	10
23	8 46 5.3	10	"	+0 47.88	— 0 14.44	18 58 53.02	39 5.02	9
30	8 12 9.2	6	B. A. C. 6548	+2 25.82	—14 5.38	19 3 18.12	29 18.97	10
Oct. 1	7 47 39.8	8	"	+3 7.15	—12 35.77	3 59.44	27 49.39	9
2	7 50 12.0	6	"	+3 50.52	—11 3.07	4 42.78	26 16.72	8
3	8 23 25.3	9	Madras 1351	—2 53.42	— 4 55.82	5 28.68	24 44.00	10
4	7 41 32.1	10	"	—2 9.61	— 3 21.82	6 12.48	23 10.02	9
6	7 35 39.4	14	"	—0 36.54	— 0 1.26	7 45.51	19 49.52	9
7	7 16 55.8	10	"	+0 10.98	+ 1 41.04	8 33.02	18 7.25	8
8	7 26 41.9	10	"	+1 0.54	+ 3 26.29	9 22.55	16 22.03	9
9	8 50 42.7	4	"	+1 51.72	+ 5 18.81	10 13.72	14 29.52	7
14	9 8 26.2	5	Gr. 12 Y. C. 1719	+0 50.98	— 9 51.28	14 40.15	4 50.00	9
15	7 27 38.5	4	"	+1 42.30	— 8 1.51	15 31.43	2 59.20	7
16	6 37 13.3	2	"	+2 36.50	— 6 1.67	16 25.61	—21 0 59.35	6
21	7 6 39.9	3	*k*	+3 36.50	— 4 57.39	21 18.64	—20 49 54.19	7
22	6 54 41.2	10	Lal. 36878	—0 57.77	— 5 2.03	22 19.60	47 35.00	8
29	7 32 19.4	8	*l*	+0 2.67	+ 8 22.00	29 46.36	29 54.38	8
Nov. 1	6 52 49.8	3	"	+3 21.68	+16 36 29	33 5.32	21 40.25	9
2	6 58 32.5	9	B.A.C.6760;G.12Y.1766	—3 34.61	—11 52.04	34 13.34	18 43.33	9
4	6 34 47.4	10	"	—1 7.95	— 6 0.41	36 29.97	12 51.61	8
5	6 33 19.2	10	"	+0 2.44	— 3 0.70	37 40.35	—20 9 52.07	8
9	6 33 42.3	5	"	+4 46 27	+ 9 40.78	42 24.13	—19 57 10.69	8
13	6 24 42.4	10	Lal. 37873	+0 35.91	— 3 2.97	47 16.40	43 42.51	8
14	6 17 26.0	5	"	+1 49.81	+ 0 25.91	48 30.33	40 13.76	9
18	5 57 39.2	4	Lal. 38164	+0 11.98	+ 4 31.83	53 32.88	25 43.25	4
(2) 21	7 1 41.2	10	Lal. 38290	+1 3.01	— 2 46.66	19 57 25.94	14 1.16	8
24	6 18 13.7	4	B. A. C. 6903	+2 43.67	+11 36.42	20 2 17.56	—19 2 17.26	9

(1) On the 20th September the wrong star was observed. The single comparison given was accidental.

(2) The planet though very minute (12 13 mag.) was well seen.

Adopted Mean Places for 1850.0 of Comparison-Stars.

*	Mag.	α h. m. s.	δ ° ′ ″	Authority.	No. of Observ
B. A. C. 6850	7	19 50 40.62	—22 36 46.01	B. A. Catalogue.	
a	9.10	19 43 25.69	22 35 1.17	W. Equat. from B. A. C. 6850.	2
e	9.10	19 47 0.45	22 21 31.86	"	6
c	10	19 45 41.87	22 7 37.74	"	5
Lal. 37507	9	19 37 36.92	21 52 49.66	Lalande's Catalogue.	
Lal. 37221	7.8	19 30 59.75	22 23 52 24	"	
B. A. C. 6507	4.5	18 55 41.72	21 57 16.93	Madras Observations 3176.	
f	9.10	18 52 9.22	22 2 44 90	W. Equat. from B. A. C. 6507.	12
g	9	18 50 36.98	22 1 30.41	" from *f*.	29
i	8	18 58 4.17	21 38 58.89	" from B. A. C. 6507.	3
B. A. C. 6548	3	19 0 50.47	—21 15 22.30	Greenwich 12 Year Catalogue.	

*	Mag.	α	δ	Authority.	No. of Observ.
		h. m. s.	° ′ ″		
Madras 1351	8.9	19 8 20.29	—21 19 57.05	Madras Observations.	
Greenwich 1719	8.9	19 13 47.50	20 55 6.58	Greenwich 12 Year Catalogue.	
k	9.10	19 17 40.60	20 45 5.68	W. Equat. from Greenwich 1719.	3
Lal. 36878	9	19 23 15.83	20 42 41.98	Lalande's Catalogue.	
Madras 1417	7.8	19 31 19.80	20 53 11.94	Madras Observations.	
l	9	19 29 42.23	20 38 25.50	W. Equat. from Madras 1417.	5
B. A. C. 6760	4.5	19 37 36.53	20 7 0.59	Greenwich 12 Year Catalogue.	
Lal. 37873	8	19 46 39.18	19 40 48.90	Lalande's Catalogue.	
Lal. 38164	8	19 53 19.63	19 30 24.47	"	
Lal. 38290	8.9	19 56 21.66	19 11 24.26	"	
B. A. C. 6903	7	19 59 32.66	—19 14 3.10	B. A. Catalogue.	

ELEMENTS AND EPHEMERIS OF CLIO.

Two normal places, depending upon ten and twelve observations, and one Washington observation by Mr. Ferguson, December 20, have furnished me data for a new orbit of *Clio* from an interval of 96.5 days.

The fundamental places are

1850. M. B. T.	☿ α	☿ δ
d.	° ′ ″	° ′ ″
Sept. 15.0	355 52 49.1	+13 54 10.7
Nov. 2.0	351 2 35.2	6 5 19.0
Dec. 20.58641	1 12 5.6	+5 10 6.4

and give the following ellipse : —

Clio, 1851, January 0.0

Mean Equinox, Mean Berlin Time.

M	65° 47′ 23″.0
☊	235 29 49.8
ω	66 25 22.2
i	8 23 1.9
φ	12 35 46.9
μ	16 34.715

whence

log. a 0.3682053

log. e 9.3386184

Period 1302.88 sid. days.

The close resemblance of these elements to the very excellent ones of Mr. Yvon Villarceau, in No. 741 of the *Astr. Nachr.*, as also to those given by Mr. Safford, in No. 20 of the *Astr. Jour.*, justified considerable confidence in these elements, even before they were compared with observation.

In the following table, all observations known to me are collected and reduced to mean Berlin time. The times of observation have been corrected for planetary aberration and the places for parallax, in order to facilitate the comparison with ephemeris.

OBSERVATIONS OF CLIO COLLECTED AND REDUCED.

Place.	Date, 1850.	☿ α	☿ δ	Authority.
	d.	° ′ ″	° ′ ″	
London,	Sept. 13.51044	356 11 15.1	+14 6 48.2	*A. N.*, XXXI. 191; *A. J.*, I. 134
London,	14.38461	356 0 33.8	13 59 35.1	" " 191; *A. J.*, I. 134
Cambridge, Eng.,	16.61567	355 32 49.1	13 39 38.7	*A. N.*, XXXI. 298
Cambridge, Eng.,	.64259	355 32 17.4	13 39 31.6	" " 298
Cambridge, Eng.,	.66411	355 32 12.8	13 39 25.0	" " 298
Durham,	.68061	355 31 57.6	13 39 11.1	" " 322
Paris,	17.52174	355 21 31 5	13 31 25.9	" " 331
Liverpool,	.52613	355 21 30.3	13 31 28.2	" " 214
Durham,	.53913	355 21 17.7	13 31 17.1	" " 322
Markree,	.55163	355 21 9.3	13 31 11.0	" " 235
Liverpool,	.56419	355 21 1.2	13 31 7.7	" " 214
Paris,	18.51844	355 9 12.3	13 22 2.0	" " 331
Cambridge, Eng.,	.52465	355 9 7.2	13 21 59.2	" " 298
Berlin,	20.37757	354 46 33.1	13 4 2.1	" " 281
Hamburg,	.43218	354 45 15.8	+13 3 10.3	*A. N.*, XXXI. 318; *A. J.*, I. 155

Place.	Date, 1850.	☿ α	☿ δ	Authority.
Berlin,	Sept. 20.48122 d.	354° 45′ 17″.2	+13° 2′ 55″.5	*A. N.*, XXXI. 309
Berlin,	21.40214	354 34 12.3	12 53 39.3	" " 281
Liverpool,	.44854	354 33 29.7	12 53 16.4	" " 303
Berlin,	.47792	354 33 11.6	12 52 56.4	" " 309
Liverpool,	.48316	354 33 10.4	12 52 53.1	" " 303
Paris,	.50854	354 32 48.6	12 52 38.7	" " 331
Cambridge, Eng.,	.51475	354 32 43.3	12 52 33.1	" " 298
Bonn,	24.53752	353 57 10.2	12 21 16.0	" " 279
Bonn,	.53974	353 56 56.0	12 21 11.4	" " 279
Hamburg,	25.35323	353 47 41.7	12 12 31.7	*A. N.*, XXXI. 237; *A. J.*, I. 155
Hamburg,	.47432		12 11 16.6	" " 318; *A. J.*, I. 155
Altona,	.48697	353 46 9.2	12 11 0.6	*A. N.*, XXXI. 238
Paris,	.49540	353 46 4.4	12 11 4.6	" " 331
Cambridge, Eng.,	.50161	353 45 59.8	12 11 1.4	" " 298
Hamburg,	26.36421	353 36 15.1	12 1 49.4	*A. N.*, XXXI. 318; *A. J.*, I. 155
Durham,	.42246	353 35 46.5	12 1 8.2	*A. N.*, XXXI. 322
Liverpool,	.42936	353 35 37.3	12 1 2.0	" " 303
Berlin,	.44168	353 35 23.1	12 0 54.3	" " 281
Liverpool,	.44321	353 35 24.0	12 0 54.8	" " 303
Bonn,	.45572	353 35 13.0		" " 279
Liverpool,	.45705	353 35 27.1	12 0 45.2	" " 303
Bonn,	.45896		12 0 44.1	" " 279
Durham,	.46524	353 35 17.7	12 0 41.3	" " 322
Hamburg,	.47100	353 35 4.8	12 0 40.8	*A. N.*, XXXI. 318; *A. J.*, I. 155
Leipsic,	27.40700	353 24 55.4	11 51 15.8	*A. N.*, XXXI. 277
Bonn,	.42579	353 24 40.7	11 50 13.9	" " 279
Bonn,	.43776	353 24 36.3		" " 279
Bonn,	.44319	353 24 29.0	11 49 59.0	" " 279
Leipsic,	.44567	353 24 29.6		" " 277
Berlin,	.45826	353 24 14.1	11 49 51.6	" " 309
Berlin,	.46827	353 24 13.9	11 49 45.3	" " 281
Bonn,	.47571	353 24 0.2	11 49 43.0	" " 280
Hamburg,	28.36344	353 14 27.5	11 39 58.1	*A. N.*, XXXI. 318; *A. J.*, I. 155
Durham,	.44212	353 13 35.9	11 39 11.1	*A. N.*, XXXI. 322
Liverpool,	.45171	353 13 27.0	11 39 2.0	" " 303
Liverpool,	.46855	353 13 17.1	11 38 49.2	" " 303
Liverpool,	.48240	353 13 8.5	11 38 40.0	" " 303
Cambridge, Eng.,	.49184	353 13 2.0	11 38 37.0	" " 298
Hamburg,	29.33938	353 4 0.0	11 29 20.2	*A. N.*, XXXI. 318; *A. J.*, I. 155
Breslau,	.38404	353 3 45.8	11 28 51.4	*A. N.*, XXXI. 237
Altona,	.41455	353 3 20.5	11 28 27.7	" " 237
Leipsic,	.47056	353 2 50.2	11 27 42.1	" " 278
Durham,	30.40610	353 53 11.8	11 17 28.9	" " 322
Hamburg,	.41656	352 53 2.5	11 17 19.4	*A. N.*, XXXI. 318; *A. J.*, I. 155
Leipsic,	.41656	352 53 10.9	11 17 0.7::	*A. N.*, XXXI. 278
Altona,	.42208	352 53 0.3	11 17 17.7	" " 238
Berlin,	.44855	352 52 46.4	11 16 58.9	" " 309
Hamburg,	.45805	352 52 38.1	11 16 51.9	*A. N.*, XXXI. 318; *A. J.*, I. 155
Göttingen,	.45812	352 52 43.4	11 16 53.7	*A. N.*, XXXI. 305
Altona,	.45812	352 52 38.3	11 16 54.4	*A. N.*, XXXI. 238; *A. J.*, I. 144
Bonn,	.46600	352 52 35.7	11 16 49.9	*A. N.*, XXXI. 280
Paris,	.47918	352 52 28.5	11 16 38.0	" " 331
Hamburg,	Oct. 1.31792	352 41 3.7	11 7 27.2	" " 318
Leipsic,	.44327	352 42 54.7	11 6 6.2	" " 277
Durham,	.46601	352 42 34.5	11 5 40.9	" " 321
Cambridge, Eng.,	.48217	352 42 27.6	11 5 31.4	" " 298
Liverpool,	.54333	352 41 49.1	11 5 51.9	" " 303
Liverpool,	.55718	352 41 46.1	11 5 42.9	" " 303
Hamburg,	2.31202	352 34 5.7	10 56 7.6	*A. N.*, XXXI. 318; *A. J.*, I. 155
Altona,	.45170	352 33 5.9	10 54 45.0	" " 238; *A. J.*, I. 144
Hamburg,	.45163	352 33 9.2	+10 54 11.2	*A. N.*, XXXI. 318

(*To be continued.*)

EGERIA.

Mr. GASPARIS having delegated to Mr. LE VERRIER the privilege of proposing a name for the last discovered asteroid, Mr. LE VERRIER has selected the name *Egeria.* Circular elements from a short interval are to be found on page 163, in Professor GOLDSCHMIDT's letter.

Professor RÜMKER, at Hamburg, has observed the planet: —

1850.	Hamburg M. T. h. m. s.	α ° ′ ″	δ ° ′ ″
Nov. 14	12 36 28.3	27 20 27.5	+8 21 56.8

and Dr. PETERSEN at Altona, as follows: —

1850.	Altona M. T. h. m. s.	α ° ′ ″	δ ° ′ ″
Nov. 13	13 22 7.9	27 34 15.6	
	25 45.2		+8 19 43.2
15	11 37 45.0	27 7 9.6	
	33 53.6		+8 24 25.0

Lieut. MAURY has communicated the following observation by Mr. FERGUSON: —

1850.	Washington M. T. h. m. s.	Comparison-Star.	Planet — Star Δα m. s.	Planet — Star Δδ ′ ″	Planet's apparent α h. m. s.	Planet's apparent δ ° ′ ″
Dec. 24	7 56 26.55	Weisse I. 501	+4 18.89	—2 5.46	1 33 28.29	+11 20 28.1

The adopted mean place of the comparison-star was,

α h. m. s.	δ ° ′ ″
1 29 9.52	+11 22 19.5

Lieutenant MAURY has also communicated [January 11] elements and an ephemeris, by Mr. G. RÜMKER.

EGERIA.

1850, November 2.0 Greenwich M. T.

M	288° 37′ 17″.0	
π	116 26 49.4	M. Eq. 1851.
☊	43 35 24.4	M. Eq. 1851.
i	15 57 59.8	
log. a	0.4082517	
ϕ	5° 31′ 9″.38	
log. μ	2.9376290	
e	0.0961805	

EPHEMERIS.

Greenwich Mean Noon.

	α h. m. s.	δ ° ′ ″	Log. Δ.
1851, January 1	1 35 58.93	+12 13 14.1	0.29681
2	1 36 23.88	12 20 25.6	
3	1 36 50.39	12 27 43.9	
4	1 37 18.45	12 35 6.9	
5	1 37 47.99	12 42 34.6	0.30711
6	1 38 19.05	12 50 6.9	
7	1 38 51.59	12 57 43.8	
8	1 39 25.58	13 5 25.0	
9	1 40 1.00	13 13 10.5	0.31730
10	1 40 37.86	13 21 0.2	
11	1 41 16.08	13 28 54.0	
12	1 41 55.70	13 36 51.8	
13	1 42 36.68	13 45 53.5	0.32734
14	1 43 18.98	13 52 58 9	
15	1 44 2.59	14 1 7.9	
16	1 44 47.48	14 9 20.4	
17	1 45 33.63	+14 17 36.4	0.33720

G.

CORRIGENDA.

Page 144, line 21 (in parenthesis), *for* Dr. WICHMANN, *read* WESTPHALEN.
" 153, col. 1, line 5, *for* April 13, *read* April 19.

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ELEMENTS AND EPHEMERIS OF CLIO.

(*Continued from page* 167.)

OBSERVATIONS OF CLIO COLLECTED AND REDUCED.

Place.	Date, 1850.	α	δ	Authority.
	d.	° ′ ″	° ′ ″	
Bonn,	Oct. 2.45958	352 33 5.0	+10 51 41.5	*A. N.*, XXXI. 280
Liverpool,	4.46732	352 14 46.0	10 32 17.2	" " 303
Liverpool,	.48117	352 14 41.7	10 32 7.7	" " 303
Durham,	5.38173	352 6 53.7	10 22 3.0	" " 321
Liverpool,	.40324	352 6 45.0	10 21 51.8	" " 303
Liverpool,	.41709	352 6 39.5	10 21 45.7	" " 303
Hamburg,	6.32489	351 59 3.5	10 11 41.5	*A. N.*, XXXI. 318; *A. J.*, I. 155
Hamburg,	.43899	351 58 14.1	10 10 22.0	*A. N.*, XXXI. 318
Altona,	.43907	351 58 11.9	10 10 20.8	" " 238
Bonn,	.44695	351 58 10.1	10 10 19.4	" " 280
Hamburg,	7.36073	351 50 59.4	10 0 15.4	" " 318
Leipsic,	.38895	351 50 55.1		" " 277
Hamburg,	.43586	351 50 21.3	9 59 22.5	" " 318
Altona,	.43595	351 50 24.0	9 59 22.7	" " 238
Bonn,	.44383	351 50 25.3	9 59 17.5	" " 280
Leipsic,	.47794	351 50 11.8	9 59 1.2	" " 277
Hamburg,	8.36261	351 43 45.7	9 49 18.3	" " 318
Hamburg,	.43275	351 43 3.2	9 48 23.1	" " 318
Altona,	.43284	351 43 3.5	9 48 24.1	" " 238
Durham,	.45026	351 42 53.1	9 48 12.4	" " 321
Hamburg,	9.31377	351 36 42.9	9 38 36.2	" " 318
Durham,	.37232	351 36 26.7	9 38 12.4	" " 321
Altona,	.42976	351 36 6.6	9 37 31.0	" " 238
Hamburg,	.42967	351 36 4.5	9 37 30.2	" " 318
Hamburg,	10.30826	351 30 19.5	9 28 1.1	" " 318
Hamburg,	.42660	351 29 26.0	9 26 51.9	" " 318
Liverpool,	11.35559	351 23 48.8	9 16 46.2	" " 303
Liverpool,	.36944	351 23 43.7	9 16 37.6	" " 303
Liverpool,	.38329	351 23 41.6	9 16 29.5	" " 303
Paris,	.44504	351 23 21.2	9 15 49.5	" " 331
Durham,	.48402	351 23 2.9	9 15 20.0	" " 321
Hamburg,	12.31818	351 18 24.0	9 6 26.8	*A. N*, XXXI. 318; *A. J.*, I. 155
Berlin,	.36128	351 18 10.9	9 6 6.9	*A. N.*, XXXI. 281
Berlin,	.40965	351 17 50.7	9 5 30.4	" " 309
Göttingen,	.42060	351 17 39.6	9 5 28.4	" " 305
Paris,	.45170	351 17 36.8	9 5 14.0	" " 331
Hamburg,	13.30227	351 13 3.4	8 56 14.1	*A. N.*, XXXI. 318; *A. J.*, I. 155
London,	14.37044	351 7 51.1	8 44 59.7	*A. J.*, I. 152
Durham,	.39570	351 7 49.3	8 44 50.8	*A. N.*, XXXI. 321
Durham,	.51284	351 7 15.9	8 43 39.1	" " 321
Berlin,	15.30209	351 3 49.4	+8 35 35.7	" " 281

Place.	Date, 1850.	α	δ	Authority.
London,	Oct. 15.38031 d.	351° 3′ 23.4″	+8° 34′ 48.0″	*A. J.*, I. 152
Paris,	16.42977	350 59 22.5	8 24 11.9	*A. N.*, XXXI. 331
Berlin,	17.37377	350 56 8.2	8 14 52 3	" " 281
Paris,	.42682	350 55 56.67	8 14 15.9	" " 331
Berlin,	18.37438	350 53 5.7	8 5 8.6	" " 281
Göttingen,	20.39704	350 48 27.6	7 45 43.7	" " 305
Berlin,	.47940	350 48 20.4	7 45 6.6	" " 281
Hamburg,	21.44178	350 46 57.6	7 36 11.4	*A. N.*, XXXI. 355; *A. J.*, I. 155
Paris,	22.41247	350 45 51.0	7 27 30.3	*A. N.*, XXXI. 331
Durham,	23.48372	350 45 4.8	7 18 6.8	" " 321
Durham,	.52486	350 45 14.1	7 17 43.9	" " 321
Durham,	26.59072	350 46 25.4	6 53 8.6	*A. N.*, XXXI. 321
Durham,	28.36720	350 48 51.9	6 38 12.0	" " 321
Washington,	.66864	350 49 41.1	6 35 51.4	*A. J.*, I. 150
Durham,	29.36763	350 50 56.7	6 30 39.2	*A. N.*, XXXI. 321
Paris,	.39323	350 51 6.9	6 30 29.4	" " 331
Washington,	.60869	350 51 38.8	6 28 50.4	*A. J.*, I. 150
Washington,	.63071	350 51 46.3	6 28 45.7	" " 150
Durham,	30.36156	350 53 27.6	6 23 25.1	" " 321
Hamburg,	.36941	350 53 47.1		*A. N.*, XXXI. 355
Hamburg,	31.45189	350 56 58.4	6 15 51.1	" " 355
Washington,	.56317	350 57 16.3	6 14 55.8	*A. J.*, I. 150
Washington,	.66972	350 57 41.1	6 14 12.7	" " 150
Washington,	Nov. 1.55901	351 0 51.3	6 8 13.0	" " 150
Washington,	.59736	351 0 59.7	6 7 58.0	" " 150
Washington,	2.58772	351 5 0.5	6 1 30.4	" " 150
Washington,	.61890	351 5 7.2	6 1 18.6	" " 150
Hamburg,	3.25456	351 7 59.2	5 57 17.9	*A. N.*, XXXI. 355; *A. J.*, I. 155
Hamburg,	.35892	351 8 15.1	5 56 37.4	" " 355; *A. J.*, I. 155
Paris,	4.37752	351 13 16.2		*A. N.*, XXXI. 331
Hamburg,	.38537	351 13 30.7	5 50 35.5	*A. N.*, XXXI. 355; *A. J.*, I. 155
Washington,	.58829	351 14 29.1	5 49 12.8	*A. J.*, I. 150
Washington,	.61445	351 14 40.7	5 49 2.8	" " 150
Washington,	5.56931	351 19 37.5	5 43 30.4	" " 150
Washington,	.57179	351 19 40.2	5 43 29.5	" " 150
Hamburg,	6.35130	351 24 13.2	5 39 8.6	*A. N.*, XXXI. 318
Paris,	.37243	351 24 15.0		" " 331
Paris,	Nov. 9.36494	351 43 44.0	5 23 42.8	" " 331
Washington,	Dec. 20.58641	1 12 5.6	+5 10 6.4	*A. J.*, I. 166

These observations, compared with an ephemeris from the elements above, give the following differences: —

COMPARISON WITH EPHEMERIS.

Place.	Date.	C. — O. Δα	C. — O. Δδ	Place.	Date.	C. — O. Δα	C. — O. Δδ	Place.	Date.	C. — O. Δα	C. — O. Δδ
London,	Sept. 13 d.	+0.3″	+3.8″	Berlin,	Sept. 20 d.	—3.3″	—6.2″	Altona,	Sept. 25 d.	+2.0″	+8.0″
London,	14	—5.3	—4.8	Hamburg,	20	+34.2	+13.2	Paris,	25	+1.1	—1.4
Cambridge, E.,	16	—2.4	+8.1	Berlin,	20	—3.0	—1.1	Cambridge, E.,	25	+1.4	—2.1
Cambridge, E.,	16	+9.3	+0 4	Berlin,	21	—6.3	+1.5	Hamburg,	26	+3.6	+6.1
Cambridge, E.,	16	—2.1	—4.7	Liverpool,	21	+2.7	—3.7	Durham,	26	—6.9	—2.5
Durham,	16	+0.8	+0.1	Berlin,	21	—0.4	—1.4	Liverpool,	26	—2.4	—0.8
Paris,	17	+2.1	0	Liverpool,	21	—3.0	—1.3	Berlin,	26	+3.6	—1.1
Liverpool,	17	0	—4.8	Paris,	21	+0.4	—2.3	Liverpool,	26	+1.6	—2.5
Durham,	17	+2.9	—1 0	Cambridge, E.,	21	—0.8	—0.5	Bonn,	26	+4.2	
Markree,	17	+2.0	—1.9	Bonn,	24	—6.4	—1.7	Liverpool,	26	—1 08	—1.9
Liverpool,	17	+0.8	—5.7	Bonn,	24	+6.3	+1.4	Bonn,	26		—2.0
Paris,	18	+3.0	—0.3	Hamburg,	25	+1.1	+2.5	Durham,	26	—6.9	—3.2
Cambridge, E.,	18	+3.5	+1.8	Hamburg,	25		+0.1	Hamburg,	26	+2.2	—6.5

Place.	Date.	C. — O. $\Delta\alpha$	C. — O. $\Delta\delta$	Place.	Date.	C. — O. $\Delta\alpha$	C. — O. $\Delta\delta$	Place.	Date.	C. — O. $\Delta\alpha$	C. — O. $\Delta\delta$
	d.	"	"		d.	"	"		d.	"	"
Leipsic,	Sept. 27	—7.9	—50.4	Liverpool,	Oct. 4	+0.1	—0.5	London,	Oct. 15	—6.8	—2.2
Bonn,	27	—5.6	—0.7	Durham,	5	+4.8	+3.3	Paris,	16	+1.8	—0.9
Bonn,	27	—9.0		Liverpool,	5	+2.6	+0.2	Berlin,	17	+1.7	—4.0
Bonn,	27	—5.3	+2.8	Liverpool,	5	+1.7	—2.2	Paris,	17	+2.8	+1.9
Leipsic,	27	—7.5		Hamburg,	6	+9.1	—2.9	Berlin,	18	+1.7	—5.3
Berlin,	27	—0.3	+0.4	Hamburg,	6	+3.1	+0.7	Göttingen,	20	+5.7	+23.7
Berlin,	27	—6.7	+0.2	Altona,	6	+5.2	+1.9	Berlin,	20	+3.5	—1.7
Bonn,	27	+2.1	—2.4	Bonn,	6	+3.4	—2.0	Hamburg,	21	—2.6	+3.6
Hamburg,	28	+0.2	+0.5	Hamburg,	7	+5.2	—3.7	Paris,	22	+0.5	+0.3
Durham,	28	+0.2	—4.2	Leipsic,	7	—3.5		Durham,	23	+6.4	—2.0
Liverpool,	28	+2.0	—3.4	Hamburg,	7	+8.6	—0.5	Durham,	23	—2.7	—0.6
Liverpool,	28	+2.7	+0.3	Altona,	7	+5.9	—0.8	Durham,	26	—7.0	—2.5
Liverpool,	28	+2.7	+0.4	Bonn,	7	+1.0	—0.8	Durham,	28	+5.0	—1.4
Cambridge, E.,	28	+3.1	+2.8	Leipsic,	7	—1.3	—7.0	Washington,	28	—8.2	—7.5
Hamburg,	29	+9.6	—5.2	Hamburg,	8	—8.5	—7.2	Durham,	29	+7.4	+1.6
Breslau,	29	—4.0	—5.9	Hamburg,	8	+3.4	+1.8	Paris,	29	+1.0	0
Altona,	29	+2.1	—2.3	Altona,	8	+3.1	+0.7	Washington,	29	+0.4	+3.4
Leipsic,	29	—2.6	+6.2	Durham,	8	+5.9	+0.9	Washington,	29	—3.8	—1.2
Durham,	30	+2.1	—1.5	Hamburg,	9	+0.5	—7.6	Durham,	30	+10.4	+2.4
Hamburg,	30	+3.7	+1.1	Durham,	9	+5.0	—2.8	Hamburg,	30	+7.3	
Leipsic,	30	—4.7		Altona,	9	+1.4	+1.1	Hamburg,	31	—1.1	—5.8
Altona,	30	+2.5	—0.9	Hamburg,	9	+3.5	+1.8	Washington,	31	+3.3	+3.5
Berlin,	30	+0.3	+0.3	Hamburg,	10	+1.7	0	Washington,	31	+0.5	+2.8
Hamburg,	30	+2.6	+1.0	Hamburg,	10	+9.0	—7.4	Washington,	Nov. 1	+0.7	+1.7
Göttingen,	30	—2.5	—0.8	Liverpool,	11	+2.6	0	Washington,	1	+2.1	+1.5
Altona,	30	+2.5	—1.5	Liverpool,	11	+2.9	—0.3	Washington,	2	+1.0	+1.2
Bonn,	30	+0.3	—1.3	Liverpool,	11	0	—1.1	Washington,	2	+2.4	+1.1
Paris,	30	0	+0.9	Paris,	11	—1.8	—0.7	Hamburg,	3	—1.2	+4.0
Hamburg,	Oct. 1	+6.9	—6.5	Durham,	11	+2.4	+3.7	Hamburg,	3	+11.3	+5.7
Leipsic,	1	—0.5	—9.1	Hamburg,	12	—4.3	+5.3	Paris,	4	+4.4	
Durham,	1	+5.8	+1.2	Berlin,	12	—5.5	—2.1	Hamburg,	4	—7.7	—11.3
Cambridge, E.,	1	+2.8	—0.2	Berlin,	12	—1.5	+3.6	Washington,	4	—4.3	—1.2
Liverpool,	1	+4.1	—1.3	Göttingen,	12	+6.0	—1.3	Washingt o	4	—7.5	—0.5
Liverpool,	1	—1.4	—1.7	Paris,	12	+1.7	—0.3	Washington,	5	+2.2	—0.5
Hamburg,	2	+5.4	—10.3	Hamburg,	13	+2.7	—2.8	Washington,	5	+3.0	—0.4
Altona,	2	+5.3	—1.1	London,	14	+1.2	+6.2	Hamburg,	6	—1.9	—7.5
Hamburg,	2	+1.5	—0.2	Durham,	14	—1.1	—0.5	Paris,	6	+0.5	
Bonn,	2	+0.7	—3.1	Durham,	14	—0.3	—1.3	Paris,	Nov. 9	+3.2	+3.3
Liverpool,	4	+3.0	—0.5	Berlin,	15	+0.6	—2.1	Washington,	Dec. 20	—0.1	0

The following Ephemeris for the convenience of observers has been computed by Mr. T. H. Safford from these elements, but without taking account of perturbations. The places are for mean Berlin noon.

M. T. Berlin.	α	δ	Log. Δ	M. T. Berlin.	α	δ	Log Δ	M. T. Berlin.	α	δ	Log. Δ
Feb. 1	16° 31′ 14″	+ 9° 2′ 17″	0.40012	Feb. 18	23° 30′ 45″	+11° 3′ 5″	0.43867	Mar. 7	30° 43′ 56″	+13° 6′ 1″	0.47111
2	16 58 12	9 9 10	0.40283	19	23 55 49	11 10 20	0.44074	8	31 9 52	13 13 10	0.47284
3	17 22 14	9 16 6	0.40523	20	24 20 65	11 17 35	0.44278	9	31 35 51	13 20 18	0.47455
4	17 46 20	9 23 3	0.40761	21	24 46 6	11 24 50	0.44480	10	32 1 52	13 27 24	0.47624
5	18 10 31	9 30 3	0.40996	22	25 11 19	11 32 5	0.44681	11	32 27 56	13 34 29	0.47791
6	18 34 46	9 37 5	0.41229	23	25 36 36	11 39 21	0.44879	12	32 54 2	13 41 32	0.47957
7	18 59 4	9 44 9	0.41460	24	26 1 56	11 46 37	0.45076	13	33 20 11	13 48 34	0.48122
8	19 23 27	9 51 14	0.41689	25	26 27 19	11 53 53	0.45271	14	33 46 21	13 55 34	0.48284
9	19 47 54	9 58 21	0.41916	26	26 52 45	12 1 8	0.45163	15	33 12 34	14 2 33	0.48444
10	20 12 25	10 5 29	0.42141	27	27 18 15	12 8 21	0.45654	16	33 38 49	14 9 31	0.48602
11	20 37 0	10 12 38	0.42364	28	27 43 48	12 15 36	0.45841	17	35 5 5	14 16 27	0.48758
12	21 1 39	10 19 48	0.42585	Mar. 1	28 9 23	12 22 52	0.46030	18	35 31 24	14 23 21	0.48912
13	21 26 21	10 26 59	0.42803	2	28 35 1	12 30 5	0.46216	19	35 57 45	14 30 12	0.49064
14	21 51 7	10 34 11	0.43019	3	29 0 42	13 37 18	0.46400	20	36 24 8	14 37 2	0.49215
15	22 15 56	10 41 24	0.43233	4	29 26 26	13 44 30	0.46583	21	36 50 33	14 43 49	0.49365
16	22 40 49	10 48 37	0.43447	5	29 52 13	12 51 41	0.46761	22	37 17 0	14 50 34	0.49513
17	23 5 45	+10 55 51	0.43658	6	30 18 3	+12 58 50	0.46936	23	37 43 29	+14 57 17	0.49658

M. T. Berlin.	α	δ	Log. △	M. T. Berlin.	α	δ	Log. △	M. T. Berlin.	α	δ	Log. △
Mar. 24	38° 10′ 0″	+15° 3′ 58″	0.49801	April 6	43° 57′ 55″	+16° 27′ 13″	0.51503	Apr. 19	49° 50′ 12″	+17° 41′ 56″	0.52910
25	38 36 34	15 10 38	0.49944	7	44 24 52	16 33 16	0.51621	20	50 17 25	17 47 16	0.53007
26	39 3 10	15 17 17	0.50084	8	44 51 51	16 39 17	0.51737	21	50 44 39	17 52 32	0.53102
27	39 29 48	15 23 53	0.50222	9	45 18 52	16 45 15	0.51852	22	51 11 55	17 57 46	0.53192
28	39 56 28	15 30 25	0.50358	10	45 45 54	16 51 9	0.51967	23	51 39 12	18 2 55	0.53282
29	40 23 11	15 36 53	0.50492	11	46 12 58	16 57 1	0.52080	24	52 6 29	18 7 58	0.53371
30	40 49 55	15 43 20	0.50624	12	46 40 3	17 2 50	0.52191	25	52 33 48	18 12 59	0.53460
31	41 16 41	15 49 45	0.50754	13	47 7 9	17 8 36	0.52298	26	53 1 8	18 17 57	0.53548
April 1	41 43 29	15 56 7	0.50883	14	47 34 16	17 14 20	0.52402	27	53 28 29	18 22 51	0.53635
2	42 10 20	16 2 26	0.51011	15	48 1 25	17 19 58	0.52504	28	53 55 52	18 27 41	0.53719
3	42 37 12	16 8 42	0.51137	16	48 28 35	17 25 33	0.52606	29	54 23 15	18 32 28	0.53799
4	43 4 5	16 14 56	0.51261	17	48 55 47	17 31 4	0.52708	30	54 50 39	+18 37 11	0.53874
5	43 30 59	+16 21 6	0.51383	18	49 22 59	+17 36 32	0.52810				

G.

FROM A LETTER OF PROFESSOR HUBBARD TO THE EDITOR.

Observatory, Washington, 1851, January 21.

I inclose the Zodiac of *Clio*, computed from your elements as first communicated. The differences between your two orbits * will not make so great a change in the zodiac as six months' perturbations. The planet can be seen in the northern limit of her zodiac only between January 15 and March 9, and in the southern limit only between July 25 and September 18. *Clio* cannot, therefore, be identical with CACCIATORE's moving star, since, although its place is not far from the northern limit of the zodiac, the dates of the observations were in May. The places given by FERNLEY in the *Astr. Nachr.*, No. 738, p. 280, as computed for May 11 and 14, 1835, should be in *South* declination.

* One communicated to Professor HUBBARD in MS., and the one on page 166, computed from slightly different data. G.

My own computations from your elements give,

	α	δ
1835, May 11.0	182° 55′	—8° 46′
14.0	182 47	—8 24

confirming GEORGE RÜMKER's result.

J. S. HUBBARD.

ZODIAC OF CLIO.

α	δ North Limit.	δ South Limit.	α	δ North Limit.	δ South Limit.	α	δ North Limit.	δ South Limit.
0°	+13° 39′	+ 4° 1′	120°	+15° 47′	+ 7° 14′	240°	—15° 15′	—22° 57′
5	15 9	5 28	125	14 16	5 56	245	15 13	23 6
10	16 33	6 50	130	12 39	4 33	250	15 2	23 7
15	17 52	8 6	135	10 58	3 6	255	14 43	23 0
20	19 5	9 15	140	9 14	1 35	260	14 15	22 44
25	20 12	10 17	145	7 27	+ 0 1	265	13 40	22 20
30	21 11	11 13	150	5 38	— 1 36	270	12 56	21 48
35	22 2	12 2	155	3 49	3 15	275	12 5	21 8
40	22 46	12 44	160	2 0	4 55	280	11 7	20 19
45	23 21	13 19	165	+ 0 12	6 35	285	10 2	19 22
50	23 49	13 46	170	— 1 34	8 14	290	8 51	18 18
55	24 9	14 5	175	3 16	9 51	295	7 33	17 6
60	24 20	14 17	180	4 54	11 26	300	6 9	15 48
65	24 23	14 22	185	6 27	12 57	305	4 40	14 23
70	24 17	14 19	190	7 54	14 24	310	3 6	12 52
75	24 3	14 8	195	9 14	15 46	315	— 1 28	11 16
80	23 40	13 50	200	10 27	17 2	320	+ 0 12	9 35
85	23 9	13 25	205	11 32	18 12	325	1 54	7 51
90	22 29	12 52	210	12 29	19 15	330	3 38	6 6
95	21 41	12 13	215	13 18	20 12	335	5 21	4 20
100	20 45	11 26	220	13 58	21 0	340	7 5	2 34
105	19 42	10 32	225	14 30	21 42	345	8 47	— 0 50
110	18 31	9 32	230	14 53	22 15	350	10 28	+ 0 51
115	17 13	8 26	235	15 8	22 40	355	12 5	2 28
120	+15 47	+ 7 14	240	—15 15	—22 57	360	+13 39	+ 4 1

OCCULTATIONS OF STARS OBSERVED AT THE CAMBRIDGE OBSERVATORY IN THE YEARS 1846, 1847, 1848, 1849, 1850.

(Continued from Vol. III. of the Memoirs of the American Academy.)

Date.	Cambridge M. T. h. m. s.	Phenomenon.	Observer.	Remarks.
1846, July 4	8 35 3.6	Im. of 28 *Libræ*	W. C. B.	Doubtful 2^s. 5-foot Equatorial.
	1.8	" "	G. P. B.	4-foot Equatorial.
Oct. 11	14 26 42.1	Em. of 68 *Geminarum*	W. C. B.	
	39.1	" "	G. P. B.	Good.
15	15 8 8.4	Em. of 34 *Sextantis*	G. P. B.	Cloudy, star faint.
Nov. 5	18 22.1	Em. of 119 *Tauri*	W. C. B.	
	21.1	" "	G. P. B.	Very faint, doubtful.
21	5 6 9.2	Im. of A. S. C. 2144	W. C. B.	Instantaneous.
	8.7	" "	G. P. B.	Observation very good, though the star is faint.
	6 3 40.7	Im. of A. S. C. 2149	W. C. B.	
	41.2	" "	G. P. B.	
	6 5 37.3	Im. of ⁎ *Sagittarii*	W. C. B.	Star of the 7 mag., 8′ S. of moon's N. limb.
	37.2	" "	G. P. B.	
	5 53 50.4	Im. of ⁎ *Sagittarii*	W. C. B.	Star of the 8 mag., 5′ S. of moon's center.
	6 7 43.2	Im. of *x Sagittarii*	W. C. B.	Star of the 11 mag., 7′ S. of moon's center.
1847, Jan. 3	8 49 53.1	Em. of 65 *Cancri*	W. C. B.	Instantaneous.
	52.1	" "	G. P. B.	
5	16 53 59.8	Em. of 34 *Sextantis*	W. C. B.	Error less than 0.5^s.
	59.8	" "	G. P. B.	
25	8 48 28.8	Im. of 61 *Tauri*	W. C. B.	Good; calm and clear.
	29.0	" "	G. P. B.	
	9 33 6.3	Em. of 61 *Tauri*	W. C. B.	Star elongated and faint.
	9.5	" "	G. P. B.	Very uncertain.
	10 18 46.2	Im. of 68 *Tauri*	W. C. B.	Double; interval 0.5^s.
	44.8	" "	G. P. B.	Very good.
Feb. 18	6 42 51.1	Em. of 86 *Piscium*	W. C. B.	May be some seconds in error.
Aug. 19	8 2 30.1	Im. of 7 *Ophiuchi*	W. C. B.	Instantaneous, no projection.
Sept. 16	7 30 8.0	Im. of 29 *Ophiuchi*	W. C. B.	
	7.7	" "	G. P. B.	
	7 17 32.6	Im. of ⁎ *Ophiuchi*	W. C. B.	Star is 2′ south of 29 *Ophiuchi*.
1848, Jan. 12	8 20 30.9	Im. of 80 *Piscium*	W. C. B.	23-foot Equatorial.
	30.7	" "	G. P. B.	5-foot Equatorial.
Feb. 12	5 1 54.7	Im. of *α Tauri*	W. C. B.	Instantaneous. 23-foot Equatorial.
	54.2	" "	G. P. B.	5-foot Equatorial.
	5 31 29.3	Em. of *α Tauri*	W. C. B.	
	26.9	" "	G. P. B.	Not instantaneous.
Mar. 11	8 6 28.8	Im. of ⁎ in *Taurus*	G. P. B.	23-foot Equatorial.
	8 9 14.0	Im. of 111 *Tauri*	G. P. B.	Good.
Apr. 12	7 48 12.3	Im. of *o Leonis*	W. C. B.	Moon obscured by clouds; uncertain.
May 4	6 41 24.1	Im. of *α Tauri*	W. C. B.	Moon obscured by clouds.
	24.5	" "	G. P. B.	Very faint.
Aug. 7	6 58 48.6	Im. of *η Libræ*	W. C. B.	Instantaneous.
Sept. 15	9 8 6.3	Em. of 65 *Ceti*	W. C. B.	
	6.5	" "	G. P. B.	
Oct. 28	5 52 52.9	Im. of *η Libræ*	W. C. B.	Star very unsteady.
1849, Jan. 5	9 52 6.7	Im. of 1319 B. A. C.	W. C. B.	23-foot Equatorial.
	6.4	" "	G. P. B.	46-inch Achromatic.
	4 15 3.2	Im. of 54 *Tauri*	W. C. B.	

Date.	Cambridge M. T.	Phenomenon.	Observer.	Remarks.
	h. m. s			
1849, Jan. 5	5 12 59.1	Em. of 54 Tauri	W. C. B.	
	8 43 28.5	Im. of 75 *Tauri*	W. C. B.	
	29.6	" "	G. P. B.	
6	5 24 27.0	Im. of 111 *Tauri*	W. C. B.	
	27.2	" "	G. P. B.	
Feb. 7	10 36 15.9	Em. of 31 *Leonis*	W. C. B.	High wind and bad vision.
9	9 22 24.2	Im. of 5 *Virginis*	W. C. B.	
Mar. 1	9 55 20.4	Im. of 1517 B. A. C.	W. C B.	Slight projection.
11	17 1 33.3	Em. of 95 *Virginis*	W. C. B.	
May 2	8 43 15.2	Im. of 5 *Virginis*	W. C. B.	Good.
	15.7	" "	G. P. B.	46-inch Achromatic.
	10 7 20.6	Em. of 5 *Virginis*	W. C. B.	Doubtful 1s. or 2s.
July 15	14 2 37.6	Em. of 54 *Tauri*	W. C. B.	Star tremulous.
	16 20 38.2	Im. of 71 *Tauri*	W. C. B.	Doubtful.
	21 25 53.7	Im. of α *Tauri*	W. C. B.	
	53.6	" "	G. P B.	
	22 39 38.0	Em. of α *Tauri*	W. C. B.	
22	7 49 58.6	Im. of 59 *Leonis*	W. C. B.	Time is doubtful 1s. or 2s.
Sept. 23	8 19 22.4	Im. of 6034 B. A. C.	W. C. B.	
27	9 22 38.8	Im. of 29 *Capricorni*	W. C. B.	
	38.2	" "	G. P. B.	Very good.
Nov. 22	6 12 32.6	Im. of 40 *Aquarii*	W. C. B.	
	30.9	" "	G. P. B.	
29	5 22 23 0	Im. of 71 *Tauri*	W. C. B.	Not a good observation.
	6 2 57.6	Im. of 77 *Tauri*	W. C. B.	Moon's limb unsteady.
	6 6 35 0	Im. of 78 *Tauri*	W. C. B.	Good.
	6 53 49.8	Im. of 1391 B. A. C.	W. C. B.	Good; a slight projection.
	9 21 50.4	Im. of α *Tauri*	W. C. B.	
	51.4	" "	G. P. B.	
1850, Jan. 23	3 23 29 0	Im. of 78 *Tauri*	W. C. B.	
	5 25 20.2	Em. of 1391 B. A. C.	W. C. B.	
	5 55 30.2	Im.	G. P. B.	Star of the 7 mag., 9′ S. of moon's center.
	5 53 39.8	Im.	G. P. B.	Star of the 10 mag.
	6 14 59.9	Im.	G. P. B.	Star of the 9 mag.
	6 35 58.9	Im.	G. P. B.	Star of the 10 mag.
	6 36 28.7	Im.	G. P. B.	Star of the 11 mag.
	6 48 34.5	Im.	G. P. B.	Star of the 10 mag.
	7 7 14.3	Im.	G. P. B.	Star of the 9 mag.
	7 18 51.3	Im.	G. P. B.	Star of the 9.10 mag.
	7 31 27.5	Im.	G. P. B.	Star of the 8 mag.
	7 14 39.1	Im. of α *Tauri*	W. C. B.	23-foot Equatorial.
	39.0	" "	G. P. B.	5-foot Equatorial.
	8 29 50.5	Em. of α *Tauri*	W. C. B.	
	50.0	Em. "	G. P. B.	
Feb. 26	8 22 6.7	Im. of 77 *Leonis*	W. C. B.	
	14 29 47.0	Im. of 3d Sat. of *Jupiter*	W. C. B.	23-foot Equatorial.
	14 32 16.0	" 2d " "	W. C. B.	
	14 34 15 2	Im. of 1st Limb "	W. C. B.	
	14 35 55.0	" 2d " "	W. C. B.	
	14 36 21.8	" 1st Satellite "	W. C. B.	
	14 48 17.7	" 4th " "	W. C. B.	
	15 35 32.0	Em. of 3d Satellite "	W. C. B.	
	15 37 31.6	" 2d " "	W. C. B.	
	15 39 43.3	" 1st Limb "	W. C. B.	
	15 41 22.1	" 2d " "	W. C. B.	
	15 42 21.4	" 1st Satellite "	W. C. B.	
	15 53 15.1	" 4th " "	W. C. B.	
Mar. 19	6 25 34 2	Em. of 1526 B. A. C.	W. C. B.	
24	6 35 48.0	Im. of 27 *Leonis*	W. C. B.	23-foot Equatorial.
	47.6	" "	G. P. B.	46-inch Achromatic.
Apr. 18	7 12 35.4	Im. of 81 *Geminorum*	W. C. B.	

Date.	Cambridge M. T.	Phenomenon.	Observer.	Remarks.
	h. m. s.			
1850, Apr. 18	7 14 50.9	Im. of ⁎ 6 mag.	W. C. B.	The star is doubtful.
15	2 1 52.7	Im. of *α Tauri*	W. C. B.	
	52.2	" "	G. P. B.	
	3 1 40.3	Em. of *α Tauri*	W. C. B.	
	36.4	" "	G. P. B.	
May 19	8 7 57.5	Im. of 77 *Leonis*	W. C. B.	
	57.0	" "	G. P. B.	
	9 22 6.9	Em. of 77 *Leonis*	W. C. B.	
June 13	8 43 51.9	Im. of 82 *Cancri*	W. C. B.	
	8 46 37.7	Im. of ⁎ 8 mag.	W. C. B.	
	9 3 21.3	Im. of ⁎ 9.10 mag.	W. C. B.	
14	5 56 26.8	Im. of *α Leonis*	W. C. B.	Very good.
	26.6	" "	G. P. B.	
	7 8 50.7	Em. of *α Leonis*	W. C. B.	Very good.
	52.2	" "	G. P. B.	
Aug. 8	37 54.4	Im. of *α Leonis*	W. C. B.	
	1 8 30.8	Em. of *α Leonis*	G. P. B.	
27	11 30 50.1	Im. of 73 *Ceti*	W. C. B.	
	48.6	" "	G. P. B.	
	12 37 8.4	Em. of 73 *Ceti*	G. P. B.	
30	0 10 14.5	Im. of *α Tauri*	W. C. B.	Disappeared instantly.
Sept. 13	8 35 48.1	Im. of 6098 B. A. C.	W. C. B.	
	8 46 24.1	Im. of ⁎ 8 mag.	W. C. B.	
Oct. 13	9 5 38.3	Im. of 7 *Capricorni*	W. C. B.	
	35.3	" "	G. P. B.	
	9 3 56.6	Im. of ⁎ 9 mag.	W. C. B.	
14	7 3 58.6	Im. of 23 *Capricorni*	W. C. B.	
	59.6	" "	G. P. B.	
21	7 59 19.0	Im. of 87 *Ceti*	W. C. B.	
	8 45 1.4	Em. "	W. C. B.	

W. C. BOND.

DEATH OF PROFESSOR SCHUMACHER.

The melancholy duty is imposed upon me, of announcing to American astronomers the decease of the venerable and honored Schumacher. He died at Altona, on the 27th December, at $11\frac{1}{2}$ A. M., aged 75 years.

Astronomy has lost in him one of its chiefest ornaments, and an earnest, single-hearted devotee, who labored for the advancement of truth, rather than for the sake of his own renown. Astronomers who knew him have lost a father or a brother. The vacancy he leaves cannot be filled.

To the great and good man who has left us, we are exclusively indebted for the establishment and continuance for thirty years of that remarkable publication, the *Astronomische Nachrichten*. This was established in September, 1821, and its thirty-one volumes have formed the principal medium of communication for the astronomers not only of Germany, but of the world.

The example of the entire abandonment of prejudices founded on state lines or geographical divisions, which Schumacher thus enabled astronomers to offer, is without parallel in the history of any other science; and it may not be too much to say, that the almost incredibly rapid advancement in astronomy since the establishment of the *Astronomische Nachrichten*, has been owing as much to the mutual influence of astronomers in different countries meeting on common ground, as to the increased facilities for publication afforded and to the energetic activity in astronomical investigation which Schumacher's journal unquestionably called into being.

But great as were his merits as a scientist, they were surpassed by his virtues as a man. His character was preeminently a lovely one. It was his delight to aid the youthful student of astronomy with prudent counsel, with fruitful suggestions, and with kind encouragement. Throughout his life, only those who have had especial opportunities of learning it can know how many animosities he soothed, how many jealousies he quieted, how many hostilities he reconciled. For himself, he had no enemies.

The latter years of his life were saddened by the embarrassments and troubles consequent upon the political disorder of the state in which he lived. Yet all that could tend to alleviate his sorrow was afforded by the spontaneous tributes and expressions of sympathy from every nation in Europe or America, that possessed an observatory or an astronomer. Probably no private man, certainly no scientific man, excepting perhaps the illustrious Gauss, ever received so much public homage as has been offered Schumacher within the last three years.

It may be excusable to refer to the earnest and almost fatherly interest with which he regarded this Journal, established on the plan of his own. Long before its commencement, the undertaking had been discussed with him, both orally and by correspondence, in all its bearings. With the discernment both of a sound judgement and a rich experience, he pointed out the difficulties, and warned against the embarrassments, while agreeing in the estimate of its advantages. And while the zeal of the professors and the liberality of the lovers of astronomy have made it possible thus far to overcome all obstacles, even their aid might have been insufficient without the warning, guiding, and helping hand of the revered Schumacher. From the commencement his support and advice have done much to sustain it, to encourage in the task of editing, and to guide in difficult and embarrassing circumstances.

The personal allusion must be pardoned, for no one, not bound by the closest of all ties, could be nearer or dearer than the venerable friend who has departed. Words will not express the loss.

> "Manibus date lilia plenis!
> Purpureos spargam flores, animamque recentis
> His saltem accumulem donis, et fungar inani
> Munere."

As he belonged to the science of the world, scientific men throughout the globe should unite in erecting a monument to his memory, worthy of his virtues and his fame.

G.

Cambridge, 1851, *January* 30.

CORRIGENDA.

Page 150, in note, *for* 532, *read* 524.
" 166, col. 2, line 4, *for* sid., *read* mean solar.
" 167, lines —4 and —5 in δ, *for* 5′, *read* 4′.

CONTENTS.

ADVERTISEMENT.

Communications for the Astronomical Journal will be addressed to the Editor, B. A. Gould, Jr., Cambridge, Mass.

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THE

ASTRONOMICAL JOURNAL.

No. 23.

VOL. I. CAMBRIDGE, MARCH 14, 1851. NO. 23.

OBSERVATIONS OF HEBE, IRIS, AND EGERIA.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

BY MR. JAMES FERGUSON.

Communicated by Lieutenant MAURY, Director of the Observatory.

[Corrected for refraction.]

HEBE.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	* — ⚴ Δα	* — ⚴ Δδ	⚴'s apparent α	⚴'s apparent δ
1850.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
April 13	9 24 34.4	3	Weisse XII. 933	+0 23.51	—12 20.82	12 54 38.31	+13 46 25.55
	9 44 46.2	15	" 929	+0 39.75	—11 53.06	54 36.81	46 31.03
14	9 56 0.6	10	" 929	—0 9.68	— 6 16.99	53 47.37	52 7.79
		10	" 933	—0 27.00	— 6 37.66	53 47.75	52 8.73
15	10 15 26.4	13	" 929	—0 59.28	— 0 52.54	52 57.77	57 31.35
	10 59 51.6	5	" 929	—1 0.88	— 0 44.31	52 56.17	57 39.57
	11 1 19.3	4	" 933	—1 18.45	— 1 5.90	52 56.30	13 57 40.86
17	10 51 42.4	8	" 929	—2 32.98	+ 8 51.11	51 24.08	14 7 15.20
		8	" 933	—2 50.53	+ 8 30.23	51 24.30	7 17.08
29	10 20 48.9	7	B. A. C. 4301	+1 24.33	— 8 57.23	42 48.64	47 33.62
	10 38 49.7	13	Weisse XII. 706	+1 28.04	— 3 44.83	42 47.89	47 33.28
30	10 39 35.4	7	" 706	+0 51.89	— 1 58.46	42 11.67	49 20.27
		7	B. A. C. 4301	+0 47.51	— 7 11.67	42 11.77	49 19.19
May 1	10 20 32.9	12	Weisse XII. 706	+0 16.95	— 0 29.07	41 36.61	50 50.28
9	9 17 57.5	6	B. A. C. 4301	—3 45.93	— 1 34.16	37 38.19	54 57.98
11	9 26 27.7	7	Weisse XII. 580	+2 18.27	— 5 12.27	36 50.07	53 36.94
12	8 38 51.9	10	" 580	+1 57.62	— 6 3.89	36 29.42	52 45.42
16	9 7 42.6	4	" 580	+0 43.19	—11 41.41	35 14.95	47 8.30
18	10 7 46.5	10	" 580	+0 13.32	—15 49.47	34 45.07	43 0.42
20	8 30 20.4	5	" 519	+3 18.41	+ 0 31.75	34 21.53	38 27.46
		5	" 525	+2 53.64	— 3 4.88	34 22.11	38 32.20
		5	" 526	+2 53.58	+ 1 43.06	12 34 22.22	+14 38 27.49

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority
		h m. s	° ′ ″	
Weisse XII. 929	8	12 53 55.76	+13 58 29.13	Weisse's Catalogue.
" 933	9	12 54 13.46	13 58 51.88	"
" 706	9	12 41 18.65	14 51 21.81	"
B. A. C. 4301	6	12 41 23.06	14 56 34.52	Rümker's Catalogue 4140.
Weisse XII. 580	8.9	12 34 30.64	14 58 51.57	Weisse's Catalogue.
" 519	8	12 31 2.15	14 37 57.61	"
" 525	9	12 31 27.39	14 41 38.43	"
" 526	9	12 31 27.56	+14 36 45.93	"

IRIS.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⚘ — * $\Delta\alpha$	⚘ — * $\Delta\delta$	⚘'s apparent α	⚘'s apparent δ	A.
1850.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
March 28	16 46 27.8	2	*b*	−1 19.45	+ 2 8.26	16 5 25.05	−24 42 0.70	8
31	13 18 17.3	13	"	−1 41.14	+ 2 57.39	5 0.44	41 11.78	9
April 4	14 18 41.8	2	"	−2 42.17	+ 5 23.05	4 2.51	38 46.55	9
13	12 22 32.9	5	B. A. C. 5345	+1 29.47	−24 36.44	0 23.45	28 0.94	8
	13 9 13.8	3	"	+1 28.29	−24 31.88	0 22.28	27 56.39	8
	14 28 14.3	3	"	+1 26.28	−24 25.16	16 0 20.26	27 49.67	8
14	12 18 8.7	10	"	+0 57.44	−22 50.12	15 59 51.44	26 14.55	9
15	12 5 16.3	8	"	+0 23.85	−21 3.17	59 17.88	24 24 27.54	10
29	12 36 46.6	10	B. A. C. 5254	+3 58.62	−15 34.84	49 1.26	23 47 9.07	8
30	11 25 4.5	1	"	+3 8.34	−12 29.22	48 10.99	44 2.39	9
May 1	11 39 26.8	16	"	+2 14.62	− 8 58.72	15 47 17.30	−23 40 31.84	9

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
b	10	16 6 43.09	−24 44 2.61	Equatorial; 8 comparisons; from B. A. C. 5403.
B. A. C. 5345	7	15 58 52.58	−24 3 21.5	B. A. Catalogue.
B. A. C. 5254	6	15 45 0.90	−23 31 32.1	B. A. Catalogue.

EGERIA.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	Egeria — * $\Delta\alpha$	Egeria — * $\Delta\delta$	Egeria's apparent α	Egeria's apparent δ	A.
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
1850, Dec. 24	7 56 26.5	7	Weisse I. 501	+4 15.89	− 2 5.46	1 33 28.29	+11 20 28.12	8
26	6 56 32.8	10	" 501	+4 40.68	+10 40.35	1 33 52.96	+11 33 13.78	10
27	6 16 19.4	8	" 539	+2 51.72	− 1 2.07	1 34 7.46	+11 39 39.14	6
. . . . .	. . . . .	. .	. . . . . .	. . . .	. . . .	. . . .	. . . .	
1851, Jan. 11	6 24 22.4	7	Weisse I. 732	+0 21.57	+10 21.52	1 40 59.16	+13 29 28.83	10
12	6 10 50.7	13	" 732	+0 59.91	+18 9.37	1 41 37.50	+13 37 16.62	9
. . . . .	. . . . .	. .	. . . . . .	. . . .	. . . .	. . . .	. . . .	
Jan. 24	7 38 34.4	12	Weisse I. 896	+0 32.37	+ 4 54.59	1 51 6.06	+15 16 55.76	7
(1) 25	7 36 57.6		*d*	0 00	0 00	1 52 0.51	+15 25 27.31	6
	7 34 7.1	5	Weisse I. 896	+1 27.33	+13 24.51	1 52 0.99	+15 25 25.61	6

(1) Contact of planet with star observed.

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
Weisse I. 501	6.7	1 29 9.53	+11 22 19.45	Weisse's Catalogue.
" 539	8.9	1 31 12.98	11 40 27.18	"
" 732	9	1 40 34.94	13 18 54.50	"
" 896	8.9	1 50 31.10	15 11 48.72	"
d	11.12	1 51 57.94	+15 25 14.97	Equatorial from W. 896; 7 comparisons.

ELEMENTS AND EPHEMERIS OF IRIS, FOR 1852.

By ERNEST SCHUBERT.

[Communicated by Lieutenant DAVIS, Superintendent of the Nautical Almanac.]

Perturbations from 1848, January 1, to 1852, June 8.

	δi	$\delta \Omega$	$\delta \varphi$	$\delta \pi$	$\delta \mu$	$\int \delta \mu$	δM
♃	$-2''.23$	$-319''.99$	$+259''.34$	$-580''.68$	$+0''.25737$	$+165''.11$	$+467''.85$
♄	$+0.69$	-10.79	$+4.03$	$+9.39$	$+0.01818$	$+12.06$	-16.71
♃ + ♄	-1.54	$-5'\ 30.78$	$+4'\ 23.37$	$-9'\ 31.29$	$+0.27555$	$+2'\ 57.17$	$+7'\ 31.14$

and the following osculating elements:—

IRIS, 1852.
Mean Equinox, M. T. Washington.
Epoch, 1852, June 8.0.

M	44° 28′ 16″.52
π	41 20 21.49
☊	259 44 5.15
i	5° 28′ 15″.59
φ	13 26 7.97
μ	963″.13955
Log. a	0.3775448

No opposition of *Iris* in 1852.

With these elements the following approximate ephemeris was computed directly from ten to ten days.

Mean Noon Washington.	☊ α	☊ δ	Log. r	Log. Δ	Mean Noon Washington.	☊ α	☊ δ	Log. r	Log. Δ
1852.	h. m.	° ′			1852.	h. m.	° ′		
Jan. 1	0 38.7	+8 18.5	0.2629	0.1812	July 9	7 46.8	+18 47.7	0.3323	0.4985
11	0 56.5	9 29.2	.2634	.2092	19	8 8.3	17 37.2	.3376	.5034
21	1 15.6	10 48.2	.2645	.2359	29	8 29.1	16 18.3	.3428	.5072
31	1 35.7	12 12.4	.2660	.2612	Aug. 8	8 49.2	14 52.1	.3480	.5096
Feb. 10	1 56.7	13 39.1	.2680	.2851	18	9 8.7	13 19.6	.3532	.5107
20	2 18.4	15 4.5	.2704	.3078	28	9 27.6	11 41.9	.3583	.5105
March 1	2 40.8	16 27.0	.2732	.3291	Sept. 7	9 45.8	10 0.2	.3633	.5088
11	3 3.7	17 41.1	.2764	.3491	17	10 3.4	8 15.7	.3682	.5057
21	3 27.1	18 53.7	.2800	.3679	27	10 20.3	6 29.2	.3731	.5010
31	3 50.9	19 54.2	.2838	.3855	Oct. 7	10 36.6	4 41.7	.3778	.4947
April 10	4 14.9	20 44.1	.2879	.4019	17	10 52.2	2 54.6	.3825	.4868
20	4 39.1	21 22.1	.2923	.4171	27	11 7.0	+1 8.6	.3870	.4771
30	5 3.5	21 47.6	.2969	.4312	Nov. 6	11 21.0	−0 34.9	.3915	.4657
May 10	5 27.7	22 0.0	.3016	.4442	16	11 34.1	2 15.2	.3958	.4525
20	5 31.8	21 58.9	.3065	.4561	26	11 46.2	3 51.7	.4000	.4375
30	6 15.7	21 44.9	.3115	.4669	Dec. 6	11 57.2	5 20.7	.4040	.4207
June 9	6 39.2	21 18.1	.3167	.4765	16	12 6.8	6 43.7	.4080	.4022
19	7 2.3	20 39.0	.3219	.4850	26	12 14.9	7 58.0	.4118	.3821
29	7 24.8	+19 48.5	0.3271	0.4923	36	12 21.3	−9 2.2	0.4155	0.3606

Cambridge, Mass., 1851, *Jan.* 17.

OBSERVATIONS OF THE FIRST COMET OF 1850, MADE AT HUDSON, OHIO.

By ELIAS LOOMIS,
PROFESSOR OF MATHEMATICS AND NATURAL PHILOSOPHY IN NEW YORK UNIVERSITY.

THE following observations were made during a short visit to Ohio last summer. The instruments employed and the mode of observation were the same as described in the Transactions of the American Philosophical Society, Vol. X. p. 10. On the first seven evenings the times were noted by Professor ST. JOHN, and on the remaining evenings by Professor BARTLETT, and without their assistance the observations would probably not have been made. The later observations have been corrected for refraction; the influence of refraction on the earlier observations was inappreciable. The publication of these results has been delayed by the difficulty of obtaining the places of the comparison-stars. The stars employed July 4 have not

yet been found in any catalogue. The apparent place of star *c* is given by Mr. R. C. Carrington in the *Astr. Nachr.*, No. 727, p. 108; and the approximate place of star *d* has been determined by differentiating from *c*. This deficiency is the more to be regretted, as the difference of declination between the comet and star *d* is much better determined than that between the comet and star *c*.

Date.	Hudson Mean Time.	No. of Comp.	Comparison-Star.	☄ — ✱		☄'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1850	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
July 3	10 9 33.5	5	*a*	—4 59.09	— 1 37.7	14 12 59.51	43 22 4.9 N.
		5	*b*	—5 22.57	+ 1 21.1	12 59.41	22 4.6
4	9 13 31.7	6	*c*	—7 52.67	—18 0.0	14 9 51.83	41 13 51.0
		6	*d*	—8 18.34	—29 38.9	. . . .	. . . .
8	8 49 8.1	2	*e*	+3 54.62	— 2 14.3	13 58 16.89	31 22 45.6
		2	*f*	—1 31.30	. . . .	58 16.87	. . . .
		2	*g*	—2 41.37	—19 5.7	58 16.98	22 41.5
9	9 18 19.6	6	*h*	+1 1.53	—29 59.4	55 35.24	28 38 23.0
		6	*i*	—4 39.04	—30 59.9	55 34.39	38 28.9
10	10 10 54.2	5	*k*	+1 0.05	+21 3.4	53 0.51	25 46 46.2
11	10 20 36.9	3	*l*	—1 4.10	+30 14.8	50 33.80	22 56 14.6
	9 35 46.1	5	*m*	—3 24.27	+18 48.5	50 39.17	23 1 16.4
15	9 18 25.2	7	*n*	+4 5.82	+22 19.6	41 55.95	14 27 18.9
		7	*o*	—0 4.64	+ 6 55.4	41 55.65	27 18.8
16	9 19 20.5	10	*p*	+1 55.67	+20 42.8	39 56.47	8 31 32.1
		10	*q*	—1 11.15	—10 58.1	39 56.48	31 40.3
18	9 33 19.8	3	*r*	+3 18.75	—10 11.3	36 8.60	2 45 16.1
		3	*s*	+2 55.78	— 7 6.6	36 8.62	45 26.4
		3	*t*	+2 42.92	— 4 57.7	36 8.53	45 29.8 N.
19	9 17 22.0	12	*u*	—0 53.31	+25 55.3	34 23.38	0 1 8.2 S.
22	9 36 1.1	12	*v*	—1 20.28	+19 24.1	29 21.43	8 4 30.6
23	9 4 22.1	11	*w*	—1 51.00	—30 41.2	27 48.78	10 32 29.4
24	8 58 18.3	15	*x*	—0 10.34	—23 11.6	26 20.33	12 57 45.1
	8 47 1.1	5	*y*	—0 22.30	—29 50.3	26 21.49	12 56 30.3
25	8 48 10.6	16	*z*	+0 20.58	+29 38.4	13 24 53.62	15 17 14.9 S.

The following are the mean places of the comparison-stars for 1850.0.

Star.	α Lalande.	Bessel.	Rümker.	Piazzi.	Taylor.	B. A. C.	Adopted Mean.	δ Lalande.	Bessel.	Rümker.	Piazzi.	Taylor.	B. A. C.	Adopted Mean.
	h. m. s.	s	s.	s.	s.	s.	s.	° ′ ″	″	″	″	″	″	″
a	14 17 57.45	57.71					57.58	43 23 26.7 N.	31.3					29.0
b	18 21.89	20.49					20.96	43 20 25.8	34.1					30.0
c	17 —						43.46	41 31 —						37.7
d	18 —						9.13	41 43 —						16.7
e	13 54 —	21.35					21.35	31 24 —	49.1					49.1
f	13 59 47.34	47.05		47.31		47.31	47.25	31 34 13.3	16.1		15.9		15.9	15.3
g	14 0 57.62	57.23					57.43	31 41 34.2	37.6					36.5
h	13 54 32.88	32.73					32.78	29 8 11.9	12.6					12.2
i	14 0 12.51		12.23	12.55	12.57		12.50	29 9 14.3		17.7	20.8	17.5		18.7
k	13 51 59.56						59.56	25 25 33.8						33.8
l	51 37.00	37.16	36.96	36.59	37.09	37.15	36.98	22 25 50.4	51.9	48.9	51.6	53.8	53.[illegible]	51.7
m	54 2.38	3.20	2.51				2.51	22 42 19.8	22.4	16.4				19.5
n	37 49.01	49.38					49.20	11 4 54.9	54.8					54.8
o	41 —	59.00	59.36				59.36	11 20 —	18.2	19.5				18.9
p	37 59.80	59.92					59.86	8 10 44.1	46.4					45.6
q	41 5.81	6.18	7.20				6.69	8 42 32.5	38.3	33.4				34.7
r	32 48.45	49.15					48.92	2 55 29.9	21.9					25.9
s	33 11.89	11.92					11.91	2 52 29.6	33.5					31.5
t	33 24.21	24.92				Santini.	24.68	2 50 28.9 N.	24.6				Santini.	26.0
u	35 15.24	16.07	15.41			15.67	15.72	0 26 56.9 S.	64.9	61.5			62.6	63.0
v	30 40.73						40.73	8 23 54.7						54.7
w	29 38.61	38.99					38.80	10 1 43.3	46.2					45.2
x	26 29.67	29.71				B. A. C.	29.69	12 34 31.8	28.6				B. A. C.	29.7
y	26 42.57			42.79	42.79	42.84	42.81	12 26 35.8			33.1	33.3	36.1	36.1
z	24 32.05						32.05	15 46 48.2						48.2

Star *w* is marked by Bessel *duplex* 4″. In my observations I did not suspect this to be a double-star, and the results may be vitiated by this circumstance.

ON THE SIMILARITY OF ARRANGEMENT OF THE ASTEROIDS AND THE COMETS OF SHORT PERIOD, AND THE POSSIBILITY OF THEIR COMMON ORIGIN.

By PROFESSOR STEPHEN ALEXANDER,
COLLEGE OF NEW JERSEY.

In a previous number of this Journal (No. 19, pp. 147 – 150), several points of resemblance in the class of comets of short period were stated, and the arrangement of their orbits was exhibited to some extent. Those particulars, as well as some others, may again be briefly recapitulated in their proper places; but it is also proposed to exhibit, side by side with them, the similar elements of the orbits of *the planets between Mars* and *Jupiter*, as far as the same have been ascertained.

For *the comets*, the elements employed have been as follows: —

For 1846, III., the latest corrected elements of Brünnow (*Astr. Nachr.*, No. 696).

For the other comets, the elements as stated in Mr. Galle's Table, viz.: —

For 1819, III., and 1819, IV., respectively, the latest elliptical elements of Encke.

For 1843, III., a mean of the eleven sets of *elliptical* elements specified in the table in question, as having been determined by as many different astronomers.

For 1844, I., a mean of the six *elliptical* elements in ditto.

For *Biela's Comet*, a mean of four sets of elements, for its return in 1846; and

For *Encke's Comet*, the elements, as stated by that astronomer, for its return in 1845.

The longitudes of the nodes were all reduced, for precession, to the same epoch, previously to the comparison of the relative position of the orbits.

For *the planets*, the elements employed were as follows, viz.: —

For *Vesta*, *Juno*, *Ceres*, and *Pallas*, respectively, Encke's osculatory elements for 1850 (*Astr. Nachr.*, No. 636).

For *Flora*, *Iris*, *Metis*, *Hebe*, and *Astræa*,* respectively, the osculatory elements, from various sources, as given in the *Supplement to the Nautical Almanac for* 1853.

For *Hygea*, D'Arrest's Elements V. (*Astr. Nachr.*, No. 716).

For *Parthenope*, Luther's Elements II. (*Astr. Nachr.*, No. 731).

For *Clio*, Gould's Osculatory Elements for January, 1851 (*Astr. Journ.*, No. 21).

For *Egeria* (as a first approximation), Rümker's Osculatory Elements for November, 1850 (*Astr. Journ.*, No. 21).

The elements of *Pallas* are for the epoch of the opposition in 1850; and as the orbit of that planet was made the plane of reference for the orbits of all the others, the longitudes of their nodes were all reduced for precession, with reference to the mean equinox of that epoch.

The individual elements of all the bodies in question have, to some extent, been separately arranged for comparison, in the manner exhibited in the various tabular forms which follow.

I. The Semi-axes.

Comets.		Planets.	
Encke's,	2.22	*Flora*,	2.202
		Clio,	2.335
		Vesta,	2.361
		Iris,	2.386
		Metis,	2.386
		Hebe,	2.426
		Parthenope,	2.451
		Egeria,	2.560?
		Astræa,	2.577
		Juno,	2.671
		Ceres,	2.768
		Pallas,	2.773
1819, IV.,	2.85		
1844, I., *De Vico's* (I.),	3.09		
1846, III., *Brorsen's* (I.),	3.15	*Hygea*,	3.122
1819, III.,	3.16		
Biela's,	$3.51\frac{1}{2}$		
1843, III., *Faye's*,	3.80		

II. Eccentricities.

Comets.		Planets.		Order of Distance
		Ceres,	0.077	11
		Vesta,	0.090	4
		Hygea,	0.094	15
		Egeria,	0.096 ?	8 ?
		Parthenope,	0.099	7
		Metis,	0.122	5
		Flora,	0.157	1
		Astræa,	0.188	9
		Hebe,	0.201	6
		Clio,	0.218	3
		Iris,	0.232	5
		Pallas,	0.240	12
		Juno,	0.255	10
1843, III.,	0.556			19
1844, I.,	0.616			14
1819, IV.,	0.687			13
1819, III.,	0.755			17

* The results of the computations with these elements of *Astræa* will, moreover, be the same as those obtained when D'Arrest's later elements (*Astr. Nachr.*, No. 731) are made use of.

Comets.		Order of Distance.
Biela's,	0.756	18
1846, III.,	0.793	16
Encke's,	0.847	2

III. Position of Nodes and Inclinations.

The arrangement, in these respects, of the orbits of the comets of short period has already been exhibited to some extent at p. 148, Vol. I., of this Journal.

As was there remarked, if the orbit of any one of the class be selected as the plane of reference, the nodes will be found to be arranged, for the most part, within very moderate limits.* The plane of the orbit of 1846, III. was, moreover, said to be that in which the nodes are most closely grouped. This same orbit is, moreover, that which, of all its class, is far the most inclined to the ecliptic.

Now, in both these respects, viz. that of being preëminently inclined to the ecliptic, and of being that in which the nodes of the other orbits are most closely grouped, the orbit of *Pallas* has a like singular position among those of the other small planets in the same region with it; and *the very inclinations themselves* of all the orbits approximate to the same values as those which are found to exist in the case of the comets. All this will be the more readily apparent, when the elements in question, as in the case of the semi-axes and eccentricities, are placed side by side. In this arrangement, as in that of the comets alone, which has already been referred to, the distance of the descending node of the orbit in question will be measured on the plane of the orbit of reference from the ascending node of the latter in the plane of the ecliptic.

The values of ☋′ and i', in the case of the comets, will be found to vary a few minutes of a degree from their values as stated at p. 148, the elements of 1846, III., employed in computing the values which follow, being the later elements of Brünnow already specified; the longitudes of the nodes being all referred to the same epoch: the value of ☋′, in the instance of *Biela's Comet*, is, moreover, marked, as it should have been, with the *negative* sign.

1850, August 23, Berlin M. T.

Longitude of Ascending Nodes in the Ecliptic and Inclination.

	First Orbit of Reference. *Comet of* 1846, III.		Second Orbit of Reference. *Pallas.*
☊	102° 45′		172° 44′
i	30 56	not very different from	34 38

On First Orbit of Reference.

Designation of Comet.	☋′	i'
1843, III., *Faye's*,	−18° 50′	35° 45′
Biela's or *Gambart's*,	−11 20	41 38
1819, III.,	− 5 45	20 30
1844, I., *De Vico's* (I.),	+ 3 48	28 43
1819, IV.,	+ 9 46	23 3
Encke's,	+15 59	40 17

On Second Orbit of Reference.

Planet's Name.	☋′	i'
Clio,	−14° 20¼′	31° 34′
Iris,	− 9 37½	34 43
Hygea,	− 5 46½	36 22¾
Juno,	+ 1 7	21 34¾
Astræa,	+ 5 30¼	30 11½
Parthenope,	+ 6 30¾	31 41
Metis,	+ 9 10	36 21½
Flora,	+ 9 48	32 16¼
Vesta,	+12 26	32 42½
Egeria,	+17 12?	46 10½ ?
Ceres,	+18 5¾	36 21¼
Hebe,	+20 56	23 47

Interval between Extremes or Range of Nodes.

On First Orbit of Reference.	On Second Orbit of Reference.
34° 49′	35° 16′

* The first traces of resemblances such as these in the case of the planets, as is well known, suggested to Olbers his hypothesis of the rupture of a planet between *Mars* and *Jupiter*, soon after the discovery of *Pallas* by himself, in 1802. (See *Monatliche Correspondenz*, VI. Band, s. 88.) Very many particulars relative to the near approach, mutual inclination, &c., of the orbits of the asteroids, with reference to the common origin of that particular class of bodies, are to be found in Dr. B. A. Gould's *Memoir* (*Astr. Nach. No.* 643, and *American Journal of Science*, 2d Series, Vol. VI. pp. 28–36).

It will be observed, that the various points of resemblance which might seem to indicate a common origin of the bodies of the one class, are nearly all found to belong to those of the other, viz.: —

1. Near approximation of the semi-axes.
2. Direct motion in every case.
3. Close grouping of similar nodes.
4. Similarity of inclination of orbits thus grouped.

In all these respects the resemblance of the individual orbits of the planets compared is more perfect than that of the comets; though the number of the former is twice as great as that of the latter; but the actual division of a planet is not, like that of *Biela's Comet*, an historical fact.

It is, however, not a little remarkable, that, in the four other particulars, the resemblance is not confined to either class, but extends to the individuals included in both. For, —

1. Comparison No. I. (of the semi-axes) exhibits in the case of the comets a series which agrees very well with that of the planets, though it extends to distances somewhat greater.

2. Among the comets, moreover, one, and only one, resembles *Pallas* in its very great inclination of orbit to the ecliptic; in which respect *Pallas* itself is equally singular among the planets.

3. The *angle of inclination to the ecliptic*, or obliquity of the one of these orbits, differs but little from that of the other; it being in the one case, as already stated, 30° 56′, and in the other 34° 38′.

4. In these respective orbits of reference, the nodes of the other orbits are most closely grouped, and, in so far as ascertained, three nodes are, moreover, arranged within very nearly the same limits; viz. those already specified at the close of Comparison III.

5. When, moreover, the *inclinations* of the two classes of orbits *to their respective planes of reference* are compared, we find the three *smaller* inclinations of 20° 30′, 23° 3′, and 28° 43′ compare very well with the inclinations of 21° 34′¾, and 23° 47′, among the planets; the mean in the one case being 24° 15′, and in the other, 22° 42′.*

6. An individual resemblance is also manifest among the *greater* inclinations of the other orbits of the two classes, though that of *Egeria* must be regarded as but a first approximation, and is perhaps too great to be placed in the same group. Including it, however, the mean of the inclinations of the ten in this group will be found to be 34° 50′+, while that of the three comets of large inclination is 39° 13′+.

In addition to these resemblances in the arrangement of the orbits, we may place in this connection, as a feature of resemblance in the constitution of the bodies themselves: —

7. That *Ceres* and *Pallas* are surrounded by a very considerable nebulosity, which, according to Schroeter, is subject to numerous changes, which, like those in the nebulous material of comets, are sometimes sudden and rapid.*

Among the approximations to coincidence, we also have, that, —

8. The nodes in the ecliptic of the orbits of reference are, at the present time, about 70° asunder; as appears from Comparison III.

9. The motion of all these bodies is direct.

It would seem to be scarcely within the bounds of probability that such an assemblage of resemblances and approximations should all be merely incidental, presenting, as the whole does, an agreement in the arrangement of two classes of bodies, *themselves, in some respects, so different*, — an agreement in their arrangements as regarded *individually or collectively*, and thus embracing such *singular* and *independent elements*, — and an agreement among these in *measure*, as well as in *mode of arrangement*.

Assuming, therefore, that a similarity and approximation extending to so many particulars must be the result of the same influence or influences exerted upon all the bodies of both classes, it will also follow, that this most probably occurred when all could be *together* exposed to such an influence; or the circumstances taken collectively seem to point to *a common origin of all the bodies concerned*, or *indicate that they formerly constituted but one mass.*

Admitting this, it would also seem that the catastrophe which separated the original mass must have been *a violent one*. The circumstances which appear to indicate this are, —

(*a.*) The very great inclination of both of the orbits of reference to the plane of the ecliptic, or even to the planes of the orbits of all the other planets.

(*b.*) The very considerable inclination, withal, of all the other orbits in question to their planes of reference themselves.

(*c.*) The close resemblance, notwithstanding this, among these last mentioned inclinations, especially in the instances of the planets, i. e. in this case, the bodies of *greater density*; as though a considerable and dense portion of the original mass had been acted upon *in a specific direction.*

(*d.*) The superior eccentricity of the orbits of the comets (as exhibited in *Comparison II.*), as well as the greater extent, upon the whole, of their semi-axes, in so far as the present state of our knowledge can enable us to make the comparison (see

* There are fewer recorded determinations of the elements of the comets of 1819, than of the other comets of short period, and the discrepancies among the elements are upon the whole greater than in the other cases. With the parabolic elements of Carlini, we shall have the following results: —

1819, III., ☋′, — 4° 46′; and i', 19° 13′.
1819, IV., ☋′, +10 57; and i', 20 8.

And the mean of the smaller inclinations of comets would then be reduced to 22° 41′; which agrees even much more closely with the mean of the inclinations of the two planets. The resemblance of the two classes of orbits in the fourth particular is not affected by the difference in these results.

* *Lilientalische Beobachtungen der neu entdeckten Planeten, Ceres, Pallas, und Juno*, Göttingen, 1805; and *Phil. Trans.* for 1807, Part II. p. 245.

Comparison I.); as though the comets having less inertia than the planets had been the more effectually displaced. This need not have happened *of course*, but is the more probable, because the eccentricity of *all* the comets is in excess, and exhibits an arrangement of them in a series, with a small and nearly uniform difference between the successive terms (if 1819, III. and *Biela's* be regarded as but one), as will appear upon an inspection of *Comparison II.*; and because three of the orbits thus arranged in the order of their eccentricities are also those which, *as a group*, show the less inclination to the orbit of reference in *Comparison III.*, and their nodes in that orbit of reference are adjacent.

(*e.*) The very difference of inertia might seem to have caused the separation, under these circumstances, of the nebulous, i. e. cometary material, from that of greater density; while portions of this same nebulous material were still retained by the larger portions of the original mass, among which *Ceres* and *Pallas* would, according to some determinations, seem to be included; while the smaller portions retained no sensible traces of nebulosity, as in the instances of most of the small planets recently discovered.*

(*f.*) The fact, that the node in the ecliptic of the orbit of reference for the planets is now some 70° in advance of that of the corresponding orbit among the comets, is not inconsistent with all that has been alleged; the inclination of the comet's orbit being somewhat less than that of *Pallas*, the motion of all the bodies in question being direct, and the orbits of the comets more exposed to perturbations, in their peculiar region, from their greater extent of semi-axes and eccentricity. The nodes, however, may have completed one or more entire revolutions.

(*g.*) The phenomenon (explained by Olbers) that the more dense bodies, viz. the planets, exhibit such varieties of light as seem to indicate that they are fragments of an irregular form.

There are other circumstances which seem to give some indication of the character of the force which effected the separation of all these bodies, and the date of its application; but a very careful examination and comparison of these will be requisite, in order to justify a plausible conclusion. Meanwhile, it seems to be desirable that the elements now compared, and especially their very remarkable resemblances, should all be placed on record, as among the very curious *statistics of the solar system*, which may be useful in future investigations, if not now.

* The reasoning here, and that which immediately precedes it, may be regarded as presenting, in effect, a modification and extension of the arguments of those who adopt Olbers's hypothesis with respect to these small planets. See, especially, *The Edinburgh Encyclopædia*, — *Astronomy*, Chap. I. Sect. X.

CORRIGENDUM.

Schumacher was born 1780, September 3, and was consequently 70 years of age at his decease, — not 75, as stated by mistake on page 175.

G.

CONTENTS.

ADVERTISEMENT.

Communications for the Astronomical Journal will be addressed to the Editor, B. A. Gould, Jr., Cambridge, Mass.
A volume consists of twenty-four numbers, with a table of contents and alphabetical index. The price of subscription is $ 5.00, payable in advance.
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THE

ASTRONOMICAL JOURNAL.

No. 24.

VOL. I. CAMBRIDGE, APRIL 11, 1851. NO. 24.

EPHEMERIS OF NEPTUNE, FOR 1851.

By SEARS C. WALKER, Esq.

From the "Smithsonian Contributions to Knowledge."

[Reprinted at the request of the author.]

Washington Mean Noon.	♆ α	♆ δ	Washington Mean Noon.	♆ α	♆ δ	Washington Mean Noon.	♆ α	♆ δ
1851.			1851.			1851.		
Jan. 1	336° 59′ 53″.34	—10° 27′ 21″.94	Feb. 8	338° 8′ 24″.38	—10° 0′ 28″.34	Mar. 18	339° 29′ 0″.91	—9° 29′ 7″.86
2	337 1 19.38	26 47.86	9	10 29.33	9 59 39.56	19	31 3.45	28 20.47
3	2 46.91	26 13.22	10	12 34.75	58 50.60	20	33 5.38	27 33.34
4	4 15.92	25 38.01	11	14 40.62	58 1.48	21	35 6.66	26 46.48
5	5 46.39	25 2.25	12	16 46.91	57 12.21	22	37 7.29	25 59.89
6	7 18.29	24 25.96	13	18 53.58	56 22.79	23	39 7.22	25 13.58
7	8 51.59	23 49.14	14	21 0.60	55 33.26	24	41 6.43	24 27.57
8	10 26.26	23 11.78	15	23 7.95	54 43.60	25	43 4.89	23 41.87
9	12 2.29	22 33.94	16	25 15.60	53 53.84	26	45 2.61	22 56.49
10	13 39.65	21 55.57	17	27 23.53	53 3.98	27	46 59.51	22 11.43
11	15 18.31	21 16.70	18	29 31.70	52 14.04	28	48 55.59	21 26.71
12	16 58.25	20 37.36	19	31 40.09	51 24.02	29	50 50.81	20 42 35
13	18 39.42	19 57.56	20	33 48.67	50 33.94	30	52 45.14	19 58.35
14	20 21.80	19 17.29	21	35 57.41	49 43.81	31	54 38 57	19 14.72
15	22 5.39	18 36.56	22	38 6.28	48 53.64	April 1	56 31.06	18 31.48
16	23 50.16	17 55.39	23	40 15.26	48 3.44	2	339 58 22.62	17 48.62
17	25 36.07	17 13.79	24	42 24.31	47 13.21	3	340 0 13.09	17 6.18
18	27 23.11	16 31.75	25	44 33.40	46 22.96	4	2 2.58	16 24.15
19	29 11.24	15 49.30	26	46 42.50	45 32.73	5	3 51.05	15 42.54
20	31 0.46	15 6.44	27	48 51.59	44 42.52	6	5 38.46	15 1.37
21	32 50.72	14 23.19	28	51 0.63	43 52.34	7	7 24.78	14 20.64
22	34 42.00	13 39.55	Mar. 1	53 9.59	43 2.20	8	9 10.00	13 40.37
23	36 34.26	12 55.52	2	55 18.45	42 12.13	9	10 54.10	13 0.55
24	38 27.52	12 11.12	3	57 27.15	41 22.11	10	12 37.07	12 21.20
25	40 21.73	11 26.37	4	338 59 35.68	40 32.18	11	14 18.88	11 42.33
26	42 16.86	10 41.27	5	339 1 44.00	39 42.32	12	15 59.51	11 3.95
27	44 12.88	9 55.83	6	3 52.10	38 52.58	13	17 38.94	10 26.06
28	46 9.76	9 10.06	7	5 59.94	38 2.95	14	19 17.14	9 48.66
29	48 7.49	8 23.97	8	8 7.49	37 13.45	15	20 54.11	9 11.77
30	50 6.06	7 37.58	9	10 14.74	36 24.08	16	22 29.82	8 35.40
31	52 5.39	6 50.90	10	12 21.62	35 34.88	17	24 4.25	7 59.56
Feb. 1	54 5.47	6 3.94	11	14 28.12	34 45.83	18	25 37.38	7 24.24
2	56 6.27	5 16.71	12	16 34.23	33 56.95	19	27 9.19	6 49.46
3	337 58 7.76	4 29.23	13	18 39.90	33 8.25	20	28 39.67	6 15.23
4	338 0 9.91	3 41.50	14	20 45.12	32 19.75	21	30 8.79	5 41.56
5	2 12.68	2 53.53	15	22 49.86	31 31.45	22	31 36.53	5 8.44
6	4 16.03	2 5.34	16	24 54.09	30 43.36	23	33 2.87	4 35.90
7	338 6 19.94	—10 1 16.94	17	339 26 57.78	—9 29 55.49	24	340 31 27.80	—9 4 3.93

Washington Mean Noon.	Ψ α	Ψ δ	Washington Mean Noon.	Ψ α	Ψ δ	Washington Mean Noon.	Ψ α	Ψ δ
1851.	° ′ ″	° ′ ″	1851.	° ′ ″	° ′ ″	1851.	° ′ ″	° ′ ″
April 25	310 35 51.29	−9 3 32.55	June 25	341 7 31.92	−8 53 12.84	Aug. 25	340 1 0.42	−9 21 35.21
26	37 13.32	3 1.76	26	7 7.62	53 24.95	26	339 59 28.25	22 12.71
27	38 33.89	2 31.59	27	6 41.58	53 37.74	27	57 55.87	22 50.26
28	39 52.96	2 2.02	28	6 13.82	53 51.21	28	56 23.32	23 27.83
29	41 10.52	1 33.06	29	5 44.33	54 5.35	29	54 50.62	24 5.41
30	42 26.55	1 4.73	30	5 13.12	54 20.18	30	53 17.82	24 42.99
May 1	43 41.02	0 37.03	July 1	4 40.22	54 35.67	31	51 44.96	25 20.56
2	44 53.93	9 0 9.97	2	4 5.65	54 51.82	Sept. 1	50 12.09	25 58.10
3	46 5.26	8 59 43.55	3	3 29.42	55 8.61	2	48 39.24	26 35.58
4	47 15.00	59 17.78	4	2 51.54	55 26.07	3	47 6.44	27 13.01
5	48 23.12	58 52.69	5	2 12.03	55 44.13	4	45 33.73	27 50.36
6	49 29.62	58 28.25	6	1 30.91	56 2.83	5	44 1.13	28 27.62
7	50 31.49	58 4.47	7	0 48.20	56 22.16	6	42 28.69	29 4.78
8	51 37.72	57 41.36	8	341 0 3.93	56 42.09	7	40 56.44	29 41.82
9	52 39.29	57 18.93	9	340 59 18.12	57 2.63	8	39 24.42	30 18.74
10	53 39.19	56 57.17	10	58 30.76	57 23.78	9	37 52.66	30 55.50
11	54 37.42	56 36.09	11	57 41.88	57 45.50	10	36 21.19	31 32.08
12	55 33.97	56 15.70	12	56 51.49	58 7.81	11	34 50.05	32 8.49
13	56 28.83	55 55.99	13	55 59.61	58 30.70	12	33 19.27	32 44.71
14	57 21.99	55 36.98	14	55 6.26	58 54.16	13	31 48.89	33 20.74
15	58 13.43	55 18.66	15	54 11.46	59 18.17	14	30 18.94	33 56.56
16	59 3.15	55 1.04	16	53 15.22	8 59 42.74	15	28 49.46	34 32.15
17	340 59 51.13	54 44.12	17	52 17.56	9 0 7.84	16	27 20.48	35 7.51
18	341 0 37.37	54 27.91	18	51 18.51	0 33.47	17	25 52.04	35 42.62
19	1 21.86	54 12.41	19	50 18.11	0 59.63	18	24 24.17	36 17.48
20	2 4.59	53 57.62	20	49 16.36	1 26.31	19	22 56.91	36 52.09
21	2 45.54	53 43.54	21	48 13.29	1 53.49	20	21 30.29	37 26.41
22	3 24.71	53 30.18	22	47 8.92	2 21.17	21	20 4.33	38 0.42
23	4 2.09	53 17.55	23	46 3.30	2 49.35	22	18 39.09	38 34.11
24	4 37.68	53 5.65	24	44 56.44	3 18.00	23	17 14.59	39 7.47
25	5 11.46	52 54.47	25	43 48.37	3 47.12	24	15 50.87	39 40.48
26	5 43.43	52 44.04	26	42 39.10	4 16.70	25	14 27.97	40 13.13
27	6 13.58	52 34.33	27	41 28.65	4 46.73	26	13 5.91	40 45.40
28	6 41.90	52 25.35	28	40 17.04	5 17.18	27	11 44.73	41 17.27
29	7 8.39	52 17.13	29	39 4.31	5 48.06	28	10 24.48	41 48.74
30	7 33.04	52 9.64	30	37 50.47	6 19.34	29	9 5.19	42 19.79
31	7 55.85	52 2.89	31	36 35.55	6 51.01	30	7 46.88	42 50.41
June 1	8 16.83	51 56.89	Aug. 1	35 19.56	7 23.05	Oct. 1	6 29.60	43 20.59
2	8 35.96	51 51.64	2	34 2.55	7 55.46	2	5 13.37	43 50.32
3	8 53.21	51 47.12	3	32 44.55	8 28.23	3	3 58.22	44 19.59
4	9 8.69	51 43.35	4	31 25.59	9 1.35	4	2 44.21	44 48.39
5	9 22.29	51 40.31	5	30 5.69	9 34.81	5	1 31.36	45 16.70
6	9 34.04	51 38.02	6	28 44.88	10 8.58	6	339 0 19.68	45 44.52
7	9 43.95	51 36.46	7	27 23.20	10 42.68	7	338 59 9.18	46 11.83
8	9 52.02	51 35.64	8	26 0.69	11 17.09	8	57 59.90	46 38.62
9	9 58.26	51 35.56	9	24 37.40	11 51.80	9	56 51.87	47 4.89
10	10 2.67	51 36.22	10	23 13.35	12 26.78	10	55 45.11	47 30.63
11	10 5.25	51 37.61	11	21 48.55	13 2.01	11	54 39.63	47 55.83
12	10 6.01	51 39.73	12	20 23.03	13 37.50	12	53 35.43	48 20.47
13	10 4.95	51 42.59	13	18 56.82	14 13.23	13	52 32.56	48 44.55
14	10 2.08	51 46.17	14	17 29.96	14 49.18	14	51 31.07	49 8.06
15	9 57.41	51 50.47	15	16 2.49	15 25.34	15	50 30.97	49 30.99
16	9 50.93	51 55.49	16	14 34.43	16 1.69	16	49 32.30	49 53.33
17	9 42.64	52 1.23	17	13 5.79	16 38.22	17	48 35.07	50 15.07
18	9 32.55	52 7.70	18	11 36.61	17 14.91	18	47 39.32	50 36.20
19	9 20.66	52 14.88	19	10 6.94	17 51.75	19	46 45.07	50 56.71
20	9 6.98	52 22.76	20	8 36.82	18 28.73	20	45 52.37	51 16.60
21	8 51.52	52 31.36	21	7 6.26	19 5.84	21	45 1.23	51 35.86
22	8 34.27	52 40.68	22	5 35.29	19 43.05	22	44 11.66	51 54.47
23	8 15.25	52 50.71	23	4 3.97	20 20.36	23	43 23.70	52 12.43
24	341 7 54.46	−8 53 1.43	24	340 2 32.34	−9 20 57.76	24	338 42 37.38	−9 52 29.72

Washington Mean Noon.	Ψ α	Ψ δ	Washington Mean Noon.	Ψ α	Ψ δ	Washington Mean Noon.	Ψ α	Ψ δ
1851.	° ′ ″	° ′ ″	1851.	° ′ ″	° ′ ″	1851.	° ′ ″	° ′ ″
Oct. 25	338 41 52.71	—9 52 46.35	Nov. 18	338 32 55.53	—9 55 50.59	Dec. 12	338 42 20.87	—9 51 38.50
26	41 9.70	53 2.30	19	32 56.63	55 48.91	13	43 8.38	51 18.63
27	40 28.38	53 17.57	20	32 59.68	55 46.46	14	43 57.75	50 58.04
28	39 48.79	53 32.14	21	33 4.70	55 43.22	15	44 48.96	50 36.73
29	39 10.93	53 46.01	22	33 11.68	55 39.22	16	45 41.99	50 14.70
30	38 34.80	53 59.18	23	33 20.62	55 34.45	17	46 36.84	49 51.97
31	38 0.42	54 11.65	24	33 31.52	55 28.90	18	47 33.50	49 28.53
Nov. 1	37 27.82	54 23.40	25	33 44.40	55 22.57	19	48 31.96	49 4.39
2	36 57.01	54 34.44	26	33 59.24	55 15.47	20	49 32.21	48 39.55
3	36 27.99	54 44.75	27	34 16.05	55 7.60	21	50 34.22	48 14.03
4	36 0.78	54 54.34	28	34 34.81	54 58.96	22	51 37.98	47 47.83
5	35 35.40	55 3.21	29	34 55.53	54 49.55	23	52 43.49	47 20.94
6	35 11.85	55 11.35	30	35 18.21	54 39.38	24	53 50.72	46 53.37
7	34 50.13	55 18.75	Dec. 1	35 42.85	54 28.44	25	54 59.65	46 25.15
8	34 30.26	55 25.41	2	36 9.45	54 16.74	26	56 10.27	45 56.27
9	34 12.26	55 31.31	3	36 37.98	54 4.28	27	57 22.56	45 26.74
10	33 56.14	55 36.47	4	37 8.44	53 51.06	28	58 36.51	44 56.57
11	33 41.89	55 40.89	5	37 40.83	53 37.09	29	338 59 52.09	44 25.76
12	33 29.51	55 44.56	6	38 15.15	53 22.37	30	339 1 9.28	43 54.34
13	33 19.07	55 47.47	7	38 51.37	53 6.91	31	2 28.04	43 22.31
14	33 10.51	55 49.62	8	39 29.49	52 50.70	32	3 48.39	42 49.68
15	33 3.87	55 51.01	9	40 9.51	52 33.76	33	339 5 10.29	—9 42 16.45
16	32 59.15	55 51.61	10	40 51.42	52 16.07			
17	338 32 56.37	—9 55 51.50	11	338 41 35.21	—9 51 57.65			

COÖRDINATES.

(x, y, and z are referred to the Apparent Equinox and Equator.)

Date 1851.	x	y	z	Log. △	Date 1851.	x	y	z	Log. △
Jan. 4	27.45465	—10.83466	—5.151569	1.4852453	July 15	27.68784	—10.31360	—4.943702	1.4661207
12	.46460	.81299	.142940	.4866945	23	.69733	.29172	.934989	.4647687
20	.47452	.79133	.134314	.4879450	31	.70680	.26982	.926278	.4636278
28	.48442	.76967	.125690	.4889786	Aug. 8	.71625	.24790	.917568	.4627247
Feb. 5	.49430	.74801	.117067	.4897749	16	.72567	.22603	.908861	.4620792
13	.50416	.72636	.108444	.4903235	24	.73507	.20419	.900155	.4617038
21	.51399	.70471	.099822	.4906177	Sept. 1	.74443	.18239	.891441	.4616118
Mar. 1	.52380	.68307	.091199	.4906541	9	.75377	.16059	.882726	.4618024
9	.53358	.66143	.082576	.4904323	17	.76310	.13879	.874010	.4622758
17	.54334	.63979	.073943	.4899564	25	.77241	.11696	.865293	.4630228
25	.55309	.61815	.065308	.4892389	Oct. 3	.78169	.09512	.856576	.4640292
April 2	.56282	.59651	.056669	.4882904	11	.79096	.07327	.847850	.4652729
10	.57252	.57487	.048023	.4871255	19	.80021	.05141	.839111	.4667290
18	.58221	.55322	.039369	.4857679	27	.80945	.02954	.830364	.4683682
26	.59189	.53154	.030703	.4842382	Nov. 4	.81868	10.00764	.821606	.4701559
May 4	.60156	.50983	.022029	.4825614	12	.82789	9.98571	.812841	.4720542
12	.61122	.48808	.013347	.4807661	20	.83708	.96377	.804067	.4740269
20	.62086	.46631	5.004654	.4788849	28	.84626	.94182	.795283	.4760340
28	.63049	.44153	4.995952	.4769480	Dec. 6	.85542	.91985	.786500	.4780348
June 5	.64010	.42274	.987245	.4749899	14	.86456	.89784	.777716	.4799910
13	.64969	.40093	.978538	.4730477	22	.87369	.87584	.768927	.4818672
21	.65926	.37910	.969832	.4711539	30	.88280	.85385	.760134	.4836268
29	.66881	.35727	.961124	.4693444	38	27.89188	—9.83185	—4.751336	1.4852396
July 7	27.67833	—10.33511	—4.952414	1.4676567					

ON THE VARIABLE LIGHT OF CLIO.

By LIEUTENANT M. F. MAURY.

A CHANGE of brilliancy worthy of notice has been observed here with regard to the recently discovered asteroid *Clio*.

Mr. FERGUSON, who is observing this planet with the large Equatorial, reports that on the nights of the 1st and 2d instant, with the ordinary illumination, the planet then appeared as a star of the 12 magnitude, and was observed without difficulty; the star of comparison being near, and of about the same magnitude.

On the night of the 3d, *Clio* could barely be observed with the faintest illumination, while the same star of comparison used on the nights of the 1st and 2d appeared as before.

On the night of March 4, the planet appeared even more brilliant than it did on the nights of the 1st and 2d instant.

Similar changes had been previously observed, which seem to suggest the probability, that the light is reflected with unequal intensity from different sides or portions of this asteroid.

National Observatory, March 5, 1851.

ELEMENTS AND EPHEMERIS OF EGERIA.

By T. H. SAFFORD.

THESE elements are computed from observations at Altona, November 13, Liverpool, December 19, 1850, and Washington, January 25, 1851.

The longitudes are referred to the mean equinox of the epoch, which is 1851, January 0.0, Greenwich mean time.

M	$298^\circ 14' 52''.0$
ω	76 15 20.1
ϕ	4 47 54.8
Ω	43 17 26.2
i	16 33 34.4
μ	14 19.903

The expressions for the equatorial coördinates are,

$$x = (9.9915437)\, r \sin (v + 208^\circ\, 20'\, 12''.1) = (0.4007342) \sin (E + 208^\circ\, 25'\, 14''.9) + 0.100177$$
$$y = (9.9139900)\, r \sin (v + 126\ 19\ 19.9) = (0.3238273) \sin (E + 126\ 13\ 34.4) - 0.142234$$
$$z = (9.7812938)\, r \sin (v + 103\ \ 6\ 22.9) = (0.1915866) \sin (E + 103\ \ 3\ 43.2) - 0.126672$$

C. — O.

	$\Delta\alpha \cos\delta$	$\Delta\delta$
Nov. 13,	$+0''.2$	$+0''.1$
Dec. 19,	+1.1	+0.4
Jan. 25,	+1.2	—0.7

A mean of the two observations for January 25, on page 178, was used.

EGERIA.

Ephemeris for Greenwich midnight.

1851.	α	δ	Log. Δ
April 0	$50^\circ 42'.1$	$+25^\circ 12'.8$	0.4809
2	51 35.6	29.5	0.4832
4	52 29.7	25 45.3	0.4854
April 6	$53^\circ 24'.3$	$26^\circ 1'.7$	0.4876
8	54 19.4	17.9	0.4898
10	55 15.1	33.9	0.4919
12	56 11.3	26 49.6	0.4939
14	57 8.0	27 5.1	0.4958
16	58 5.2	20.4	0.4976
18	59 3.0	35.4	0.4995
20	60 1.3	27 50.2	0.5013
22	61 0.3	28 4.7	0.5030
24	61 59.5	18.8	0.5046
26	62 58.9	32.7	0.5062
28	63 59.0	46.3	0.5077
30	64 59.6	28 59.5	0.5092

LETTER FROM PROFESSOR BACHE TO THE EDITOR.

Washington, March 24, 1851.

BY permission of the Hon. THOMAS CORWIN, Secretary of the Treasury, I inclose you, for insertion in the *Astronomical Journal*, the lists of observations of moon-culminations, made for the use of the Coast Survey, in August and September, 1850, at Cambridge, Philadelphia, and Point Conception in Upper California, with the longitude of Point Conception as

computed from the observations. The latitude of the station-point, as deduced from observations by Assistant George Davidson, is 34° 26′ 56″ north.

A. D. BACHE,
Superintendent U. S. Coast Survey.

I. *Moon-Culminations observed in August and September*, 1850, *at Point Conception, Upper California* (*Section* IX. *U. S. Coast Survey*), *by* George Davidson, *Esq., Assistant.*

Date, 1850.	Object.	Observed R.A. h. m. s.	No. of Wires.	Date, 1850.	Object.	Observed R.A. h. m. s.	No. of Wires.
Aug. 12	α Virginis	13 17 17.62	5	Aug. 22	β Ceti	24 36 6.06	5
	Moon I.	13 54 8.93	5	23	β Aquarii	21 23 42.00	5
13	α Virginis	13 17 17.31	5		α Aquarii	21 58 7.12	5
	Moon I.	14 46 26.22	5		σ Aquarii	22 22 44.74	5
	β Libræ	15 8 57.43	4		λ Aquarii	22 44 49.72	5
	δ Ophiuchi	16 6 30.65	5		7980 B. A. C.	22 46 43.71	5
14	β Libræ	15 8 57.59	5		8081 B. A. C.	23 6 35.68	5
	Moon I.	15 38 22.83	5		8109 B. A. C.	23 10 8.86	5
	5303 B. A. C.	15 51 30.45	4		Moon II.	23 19 3.60	5
	δ Ophiuchi	16 6 30.77	5		ι Piscium	23 32 16.60	5
15	β Libræ	15 8 57.72	5		λ Piscium	23 34 26.12	5
	5303 B. A. C.	15 51 30.19	5		20 Piscium	23 40 16.43	5
	β′ Scorpii	15 56 44.98	5		8368 B A. C.	23 57 41.93	5
	δ Ophiuchi	16 6 30.95	5		62 B. A. C.	0 11 49.35	5
	5437 B. A. C.	16 10 25.20	5	24	ι Piscium	23 32 16.87	5
	φ Ophiuchi	16 22 35.31	5		λ Piscium	23 40 16.36	5
	5539 B. A. C.	16 26 35.43	5		20 Piscium	23 34 26.13	5
	Moon I.	16 30 24.86	5		33 Piscium	23 57 42.85	5
	5579 B. A. C.	16 32 56.37	5		Moon II.	0 6 48.37	5
	5781 B. A. C.	17 1 49.09	5		62 B. A. C.	0 11 49.38	5
	μ Sagittarii	18 6 49.41	5		10 Ceti	0 18 58.31	5
16	α Scorpii	16 20 14.58	5		242 B. A. C.	0 45 22.95	5
	5781 B. A. C.	17 1 48.34	5		θ′ Ceti	1 16 33.77	5
	Moon I.	17 21 38.45	5	26	θ′ Ceti	1 16 34.08	5
	ξ Serpentis	17 29 2.19	4		μ Piscium	1 22 22.29	5
	ο Serpentis	17 33 1.08	5		518 B. A. C.	1 33 40.20	5
	μ Sagittarii	18 4 49.82	5		ο Piscium	1 37 31.10	5
17	ξ Serpentis	17 29 2.00	3		Moon II.	1 43 39.99	5
	ο Serpentis	17 33 1.05	5		525 B. A. C.	1 54 19 57	5
	Moon I.	18 15 2.27	5	27	ο Piscium	1 37 30.73	5
	λ Sagittarii	18 18 45.02	5		ξ′ Ceti	2 5 5.44	5
	ν′ Sagittarii	18 45 9.39	5		760 B. A. C.	2 20 13.12	3
20	α^2 Capricorni	20 9 45.96	5		ν Ceti	2 28 2.44	5
	β Capricorni	20 12 37.10	5		Moon II.	2 34 14.63	5
	7012 B. A. C.	20 20 20.49	5		α Ceti	2 54 28.40	5
	Moon I.	20 50 2.12	5		1057 B. A. C.	3 16 46.61	5
	29 Capricorni	21 7 28.91	5	28	ν Ceti	2 28 2.39	5
	ι Capricorni	21 13 55.47	5		γ Ceti	2 25 34.05	5
	β Aquarii	21 23 42.06	5		845 B. A. C.	2 36 52.77	4
21	29 Capricorni	21 7 29.13	5		α Ceti	2 54 28.22	5
	ι Capricorni	21 13 56.12	5		1057 B. A. C.	3 16 46.31	5
	7114 B. A. C.	21 29 48.45	5		ξ Tauri	3 19 4.32	5
	7543 B. A. C	21 34 19.33	5		Moon II.	3 27 15.62	5
	Moon I.	21 39 57.74	5		1147 B. A. C.	3 40 5.18	4
	μ Capricorni	21 45 9.27	3		α Tauri	4 27 20.48	5
	α Aquarii	21 58 7.27	5	29	ξ Tauri	3 19 4.55	5
22	α^2 Capricorni	20 9 45.72	5		η Tauri	3 38 36.47	5
	β Aquarii	21 23 41.92	5		λ Tauri	3 52 24.16	4
	δ Capricorni	21 38 47.63	5		Moon II.	4 23 19.76	5
	μ Capricorni	21 45 9.11	5		α Tauri	4 27 20.50	5
	7773 B. A. C.	22 8 57.24	5	30	η Tauri	3 38 36.09	5
	σ Aquarii	22 22 44.67	5		ε Tauri	4 19 53.49	5
	Moon II.	22 30 57.66	5		α Tauri	4 27 21.81	5
	8109 B. A. C.	23 10 8.56	5		Moon II.	5 22 42.32	5

Date, 1850.	Object.	Observed R.A.	No. of Wires.	Date, 1850.	Object.	Observed R. A.	No. of Wires.
		h. m. s.				h. m. s.	
Sept. 9	Moon I.	14 23 11.98	5	Sept. 24	ξ Ceti	2 20 14.02	5
	δ Ophiuchi	16 6 30.33	5		ν Ceti	2 28 2.86	5
10	α^2 Libræ	14 42 36.36	5		γ Ceti	2 35 34.47	
	β Libræ	15 8 57.50	5		929 B. A. C.	2 51 43.38	4
	Moon I.	15 14 41.66	7		α Ceti	2 54 30.06	5
11	α^2 Libræ	14 42 36.09	5		Moon II.	3 10 49.43	7
	β Libræ	15 8 57.23	5		o Tauri	3 16 47.67	5
	β' Scorpii	15 56 44.59	5		ξ Tauri	3 19 5.08	5
	Moon I.	16 9 55.24	7		η Tauri	3 38 28.35	5
	η Ophiuchi	17 1 48.19	5	25	o Tauri	3 13 41.84	5
	μ' Sagittarii	18 4 49.67	5		ξ Tauri	3 19 5.09	5
12	β' Scorpii	15 56 44.30	5		η Tauri	3 38 37.13	5
	α Scorpii	16 20 14.21	5		Moon II.	4 5 46.99	7
	Moon I.	17 2 3.62	7		ε Tauri	4 19 53.94	5
	θ Ophiuchi	17 12 49.60	5		α Tauri	4 27 21.21	5
	μ' Sagittarii	18 4 49.47	5	26	η Tauri	3 38 37.95	5
15	μ' Sagittarii	18 4 49.61	5		ε Tauri	4 19 53.90	5
	o Sagittarii	18 55 43.78	5		α Tauri	4 27 21.09	5
	π Sagittarii	19 0 52.81	5		Moon II.	5 3 28.82	7
	6760 B. A. C.	19 37 38.96	5		ξ Tauri	5 28 42.78	5
	Moon I.	19 40 53.72	7	27	α Tauri	4 27 21.56	5
	β Capricorni	20 12 38.17	3		o Tauri	5 18 40.04	5
	7042 B. A. C.	20 20 20.81	4		ξ Tauri	5 28 43.22	5
18	δ Capricorni	21 38 47.57	5		Moon II.	6 3 43.09	7
	μ Capricorni	21 45 8.70	5		μ Geminorum	6 13 55.14	5
	α Aquarii	21 58 6.81	5		γ Geminorum	6 29 4.52	5
	Moon I.	22 11 45.44	7		ε Geminorum	6 34 44.02	5
	σ Aquarii	22 22 44.61	5		δ Geminorum	7 11 11.43	5
19	β Aquarii	21 23 42.04	5	28	μ Geminorum	6 13 55.48	5
	α Aquarii	21 58 7.23	5		γ Geminorum	6 29 4.89	4
	θ Aquarii	22 8 57.63	5		ε Geminorum	6 34 44.37	5
	Moon I.	23 0 20.42	7		Moon II.	7 5 45.76	7
	γ Piscium	23 9 26.29	5		δ Geminorum	7 11 11.59	5
	θ Piscium	23 20 24.55	5	29	μ Geminorum	7 25 3.33	5
20	α Aquarii	21 58 7.05	5		β Geminorum	7 36 9.47	5
	Moon II.	0 10 36.54	7		Moon II.	8 8 29.09	7
24	θ' Ceti	1 16 35.36	5				

II. *Moon-Culminations observed by Professor* E. Otis Kendall, *at the Observatory of the Central High School, Philadelphia, Pa.*

Date, 1850.	Object.	Observed R.A.	No. of Wires.	Date, 1850.	Object.	Observed R.A.	No. of Wires.
		h. m. s.				h. m. s.	
Aug. 16	5579 B. A. C.	16 32 56.12	5	Aug. 26	Moon II.	1 37 26.03	5
	Moon I.	17 16 3.65	4		ξ' Ceti	2 5 5.27	5
	ξ Serpentis	17 29 2.12	5	27	o Piscium	1 27 30.97	5
	o Serpentis	17 33 1.25	5		ξ' Ceti	2 5 5.40	5
17	ξ Serpentis	17 29 2.20	5		Moon II.	2 27 45.45	5
	o Serpentis	17 33 1.29	5		845 B. A. C.	2 36 52.25	4
	Moon I.	18 8 27.03	5	Sept. 12	Moon I.	16 56 22.87	5
	λ Sagittarii	18 18 45.35	5		η Ophiuchi	17 1 48.26	5
	ν' Sagittarii	18 45 9.13	5	13	Moon I.	17 49 25.42	5
21	ι Capricorni	21 13 55.95	5		μ' Sagittarii	18 4 49.38	5
	Moon I.	21 33 44.32	5		λ Sagittarii	18 18 44.76	2
	δ Capricorni	21 38 47.94	5	14	μ' Sagittarii	18 4 49.50	5
	μ Capricorni	21 45 9.29	5		λ Sagittarii	18 18 44.87	4
25	33 Piscium	23 57 42.08	5		Moon I	18 42 10.79	5
	10 Ceti	0 18 58.30	5		o Sagittarii	18 55 43.65	5
	Moon II.	0 48 41.95	5		π Sagittarii	19 0 52.59	5
	e Piscium	1 0 40.97	4	16	α^2 Capricorni	20 9 46.06	5
	μ Piscium	1 22 21.85	5		Moon I.	20 25 45.60	5
26	μ Piscium	1 22 22.13	5		η Capricorni	20 55 53.91	5

Date, 1850.	Object.	Observed R.A.	No. of Wires.	Date, 1850.	Object.	Observed R. A.	No. of Wires.
		h. m. s.				h. m. s.	
Sept. 16	ν Aquarii	21 1 27.60	5	Sept. 21	Moon II.	0 32 48.81	6
19	σ Aquarii	22 22 44.96	6		20 Ceti	0 45 23.14	6
	Moon I.	22 51 15.79	6		e Piscium	1 0 41.29	6
	γ Piscium	23 9 26.16	6	22	20 Ceti	0 45 23.34	2
	θ Piscium	23 20 24.27	6		e Piscium	1 0 41.52	6
20	γ Piscium	23 9 25.95	6		Moon II.	1 21 43.79	6
	θ Piscium	23 20 24.18	6		ν Piscium	1 33 40.28	6
	Moon I.	23 42 28.00	6		o Piscium	1 37 31.30	6
	*Moon II.	23 44 32.85	6	27	o Tauri	5 18 39.79	6
	27 Piscium	23 51 2.04	6		ζ Tauri	5 28 42.94	6
	33 Piscium	23 57 41.89	6		Moon II.	5 56 1.15	6
21	27 Piscium	23 51 2.25	6		γ Geminorum	6 29 4.43	6
	33 Piscium	23 57 42.07	6		ϵ Geminorum	6 34 43.73	6

* Not quite full.

III. *Moon-Culminations observed at Harvard Observatory, Cambridge, Mass., by* WM. CRANCH BOND, *Esq., Director.*

Date, 1850.	Object.	Observed R.A.	No. of Wires.	Date, 1850.	Object.	Observed R A.	No. of Wires.
		h. m. s.				h. m. s.	
Sept. 16	Moon I.	20 25 11.71		Sept. 17	s Capricorni	21 38 48.17	
	η Capricorni	20 55 54.22			p Capricorni	21 45 9.36	
	β Aquarii	21 23 41.92		29	δ Geminorum	7 11 11.23	
17	η Capricorni	20 55 51.37			β Geminorum	7 36 8.96	
	ν Aquarii	21 1 27.37			Moon II.	8 59 54.06	
	Moon I.	21 15 36.55					

From these observations, Mr. WALKER has computed the longitude of Point Conception west of Greenwich as follows, assuming Harvard Observatory to be $4^{h.}\ 44^{m.}\ 39^{s.}.5$, and Philadelphia Observatory $5^{h.}\ 0^{m.}\ 37^{s.}.3$, west of Greenwich.

	Concluded Longitude.	Weight.
	h. m. s.	
By Moon I., with Philadelphia, Aug. 16,	8 1 43.30	0.002067
I., " 17,	43.03	0.002649
I., " 21,	47.44	0.002006
I., " Sept. 19,	34.31	0.002298
II., " Aug. 26,	51.39	0.001144
II., " 27,	55.95	0.001828
II., " Sept. 27,	44.74	0.003639
II., with Cambridge, Sept. 29,	26.85	0.001859

Whence we have finally for the longitude of Point Conception

	Arithmetical Mean.	Mean by Weights.	Weight.	Probable Error.
	h. m. s.	h. m. s.		
By Moon I.,	8 1 42.03	8 1 41.61	0.009020	
II.,	8 1 44.73	8 1 43.67	0.008470	
Mean by both limbs,	8 1 43.38	8 1 42.64	0.017490	$\pm 1^{s}.3$

REMARKS BY THE EDITOR.

In closing the first volume of the Astronomical Journal, it may not appear amiss to say a word regarding its past and future management. The spirit in which it is edited may be sufficiently inferred from the contents of the volume which has now appeared, but the number of inquiries which have been addressed to the Editor upon particular points seem to indicate that some additional explanation is desirable.

The province of this Journal, as has been already stated in the preamble, comprises researches in all the branches of Astronomy, as well as such investigations in kindred sciences as may bear upon astronomical problems. But it extends no farther; and in those branches which are embraced within the sphere of the Journal, its province includes original researches only, — to the exclusion of articles designed merely for the diffusion of astronomical information. And articles are not reprinted from other publications, except, in some peculiar cases, at the especial request of the author.

It will have been observed, that, in order to avoid the consequences of accidental errors, so far as is possible, such errors are uniformly published as "Corrigenda" in the first number issued after they have been detected or communicated. This may very naturally have led to the suspicion, that sufficient care is not expended on the revision of the press; and the Editor therefore feels it due to himself to state, that, although every error of this kind discovered has been pointed out, not more than one tenth of the errors published are typographical; the remainder having been contained in the original manuscripts. This degree of correctness would, however, scarcely have been attainable, were it not for the great vigilance and care exercised by Mr. Bigelow, the accomplished corrector of the press, to whom the best acknowledgements are due.

In consequence of suggestions from various quarters, appropriate editorial notices of such new works as may be published for the use of astronomers will be given from time to time. In all other respects the Journal will be conducted in the same manner as before, with the hope of receiving the approval of astronomers.

B. A. GOULD, Jr.

Cambridge, 1851, *April* 7.

CORRIGENDA.

Page 31, col. 2, line 1, *for* $K_s^{(i)}$, *read* $k_s^{(i)}$.
" " " " 2, " $18\, b_s^{(i)}$ " $9\, g_s^{(i)}$.
" " line 2 of formula, *after* λ^6, *insert* α^3.
" 32, " 3 " *for* $(i+6)$, *read* $(i+1)$.

Page 171, col. 2, lines —3 and —4, *for* 13°, *read* 12°.
" " " " —15, " 65″, " 55″.
" 177, line 7, *for* ✱ — ⚱, *read* ⚱ — ✱.
" 182, col. 1, line —10, " ☊′ " ☋′.
" 183, " " 30, " three " these.

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COMET-CIRCULAR.

Mr. George P. Bond, assistant at the Cambridge Observatory, discovered a Comet last evening, between ten and eleven o'clock, in Camelopardalus. Its position, referred to the mean equinox of 1850.0, was

1850.	M. T. Cambridge.	α	δ
August 29	$11^{h.}\ 9^{m.}\ 45^{s.}$	$3^{h.}\ 24^{m.}\ 49^{s.}.7$	$+58°\ 0'\ 37''.9$

Hourly motion in α, $+28^{s.}$. Hourly motion in δ, $-33''$.

Mr. Bond describes the Comet as being quite faint.

B. A. GOULD, Jr.

Cambridge, *August* 30, 1850.

By a later observation, Mr. Bond finds,

1850.	M. T. Cambridge.	α	δ
August 30	$9^{h.}\ 44^{m.}\ 43^{s.}$	$3^{h.}\ 35^{m.}\ 45^{s.}.7$	$+58°\ 7\ 19\ 2$

B. A. G.

Cambridge, *August* 31, 1850.

ASTRONOMICAL JOURNAL.

EXTRA.

NEW PLANET.

Mr. de Gasparis discovered in Naples, November 2, a New Planet, resembling a star of the 9.10 magnitude.

Professor Schumacher announces the discovery in a circular dated November 14, and states that Mr. de Gasparis made the discovery by means of the Zones in the vicinity of the ecliptic, which he had constructed to aid him in his search for planets.

The observations are,

At Naples, by Mr. de Gasparis.

1850.	M. T. Naples. h. m. s.	α	δ
November 2	7 3 6.5	30° 31′ 49″.9	+7° 58′ 55″.0
3	7 21 41.4	30 14 58.3	+8 0 18.5

At Altona, by Dr. Petersen.

1850.	M. T. Altona. h m. s.	α	δ
November 13	13 25 45.2	27° 34′ 25″.0	+8° 19′ 38″.6

Dr. Petersen estimates it as of the 10 magnitude.

B. A. GOULD, Jr.

Cambridge, 1850, *December* 6.